BRISTOL

INSTRUCTION NO. T500FT

SERIES 500 2-CASE TEMPERATURE PROGRAM
CONTROLLER WITH ELECTRONIC CONTROLS

INSTRUCTIONS

INSTALLATION
OPERATION
& SERVICE

THE BRISTOL COMPANY WATERBURY, CONN. 06720

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PLACE THESE INSTRUCTIONS WITH THE MAN IN CHARGE OF YOUR INSTRUMENTS

I M P O R T A N T

- Read these instructions NOW before installing instrument.
- Keep these instructions permanently & accessibly filed for future reference.
- Be sure to specify MODEL & SERIAL numbers when ordering parts, instructions, diagrams or data.
- Ship instruments or parts for repair or exchange only to Bristol's main or branch factories—not to Sales Offices.
- Be sure to—
  1. Identify your shipments with your exact return address & order number.
  2. Write nearest Bristol Factory or office giving your order number, directions & address for return shipment, full instructions for repair, etc.
- Report damage to shipments at once to shipping company. The **customer assumes responsibility for collecting any claim for damages** from the shipping company, on all shipments made on a collect basis.

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Completely trained and fully equipped, Bristol Service Engineers will serve you at far less than the cost of maintaining your own staff of instrument specialists.
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THE BRISTOL COMPANY
WATERBURY, CONN. 06720 U.S.A.

INSTRUCTION NO. T500FT

SERIES 500 2-CASE TEMPERATURE PROGRAM
CONTROLLER WITH ELECTRONIC CONTROLS

FOR SERIAL NO. _____ CUST. ORDER NO. _____

ITEM	DESCRIPTION	NUMBER
1	Program Controller Instructions	B2042
2	Template for Max. Rise of Cam (with Spring Cam Drive)	018689
3	Template for Max. Rise of Cam (with Electric Cam Drive)	018691
4	Standard Wiring Diagrams	B2032
5	Parts List for Program Controller	W18203
6	Thermometer Case Connections and Color Code	Sh-011037
7		
8		
9		
10		
11		
12		
13		
14		
15		
	PLUS FOLLOWING ITEMS AS REQUIRED	
	INSTRUCTIONS	
	WIRING DIAGRAMS	
	Special if required	

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INSTRUCTION NO. B2042
INSTALLATION, OPERATION AND SERVICE BRISTOL SERIES 500 ELECTRONIC FREE-VANE SINGLE AND TWO-CASE PROGRAM CONTROLLERS

Herewith: Sheet nos. 018689 & 018691

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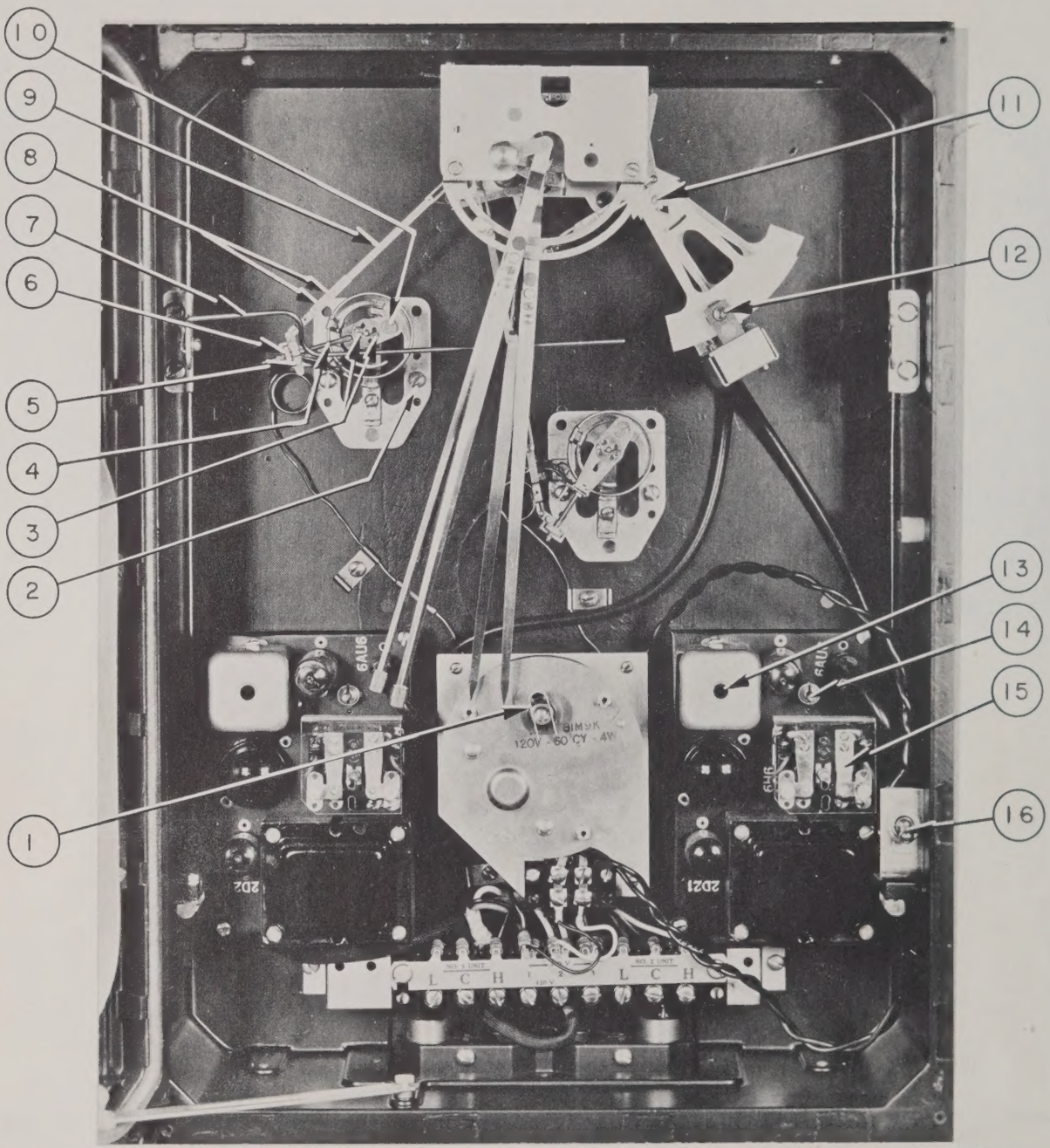


FIGURE 1. TYPICAL SERIES 500 2-PEN, 2-CONTROL ELECTRONIC RECORDING SECTION OF A TWO-CASE PROGRAM CONTROLLER.

CODE TO FIGURE 1

1. Chart drive hub
2. Element mounting screws
3. Friction disk assembly (coarse zero adjustment)
4. Element driving lever arm
5. Span adjustment locking screws
6. Span adjustment
7. Pen lifter
8. Linearity locking screws
9. Connecting link
10. Fine zero adjustment
11. Vane control point adjustment
12. Control coils
13. Differential gap adjustment
14. Control unit control point adjustment
15. Relay
16. Instrument on-off switch

PART I GENERAL

A. Description

Bristol Program Controllers sequence changes in a measured variable. The rate of rise, fall and hold time of the variable, such as temperature, pressure, flow, etc., are programmed by a cam mechanism.

There are two types of program controllers.

1. Single-Case: This type of program controller consists of a programming unit and one or two control units in one case controlling a single measured variable.

2. Two-Case: This type of controller consists of a programming unit in one case and 1, 2 or 3 control units in another case controlling one or two measured variables.

Single and Two case programmers are available with many different combinations of cams and control options as described below. A wide variety of cam speeds are available. The cam is pre-cut either at the factory or on the job for the desired process program. A cam follower positions the set-point of the control unit. The instrument containing the control unit consists of a standard measuring system for (pressure, liquid level, temperature, flow, position, etc.) with the necessary recording components.

The programming instrument utilizes a cam driven by a synchronous timing motor.

Program controllers with one control unit provide L, H or LH type control and are equipped with one set-point index which is actuated by the cam follower arm.

Program controllers with two control units can provide LOH or LNH type control for one measured variable or are sometimes wired to provide an LH type control for each of two measured variables.

Two pen controllers with three control units can be wired to provide LH control on one pen and LOH on the other. Separate wiring diagrams are furnished to cover these applications.

The electronic control units are especially adapted for easy installation, interchangeability and simplified service.

B. Types of Control

Series 500 Electronic Program Controllers can be furnished with any of five standard types of control: L, H, LH, LOH or LNH. Special control circuits are also available on order.

1. L Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable back to the set-point. When the measured variable goes above the set-point index, the "L" load is deenergized.

2. H Control. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable. When the measured variable is lower than the set-point index, the "H" load is deenergized.

3. LH Control. When the measured variable is lower than the set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is higher than the set-point index, a **high** control load is energized to lower the measured variable.

4. LOH Control. When the measured variable is lower than the low set-point index, a **low** control load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, both high and low loads are deenergized. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **off** band and is adjustable from 0 to 100% of the total range of the instrument. If instrument contains a fixed band, the band is not adjustable from 0 to 100%.

5. LNH Control. When the measured variable is lower than the low set-point index, a **low** load is energized to raise the measured variable. When the measured variable is between the low and high set-point indexes, a **normal** control load is energized to maintain the normal value of the measured variable. When the measured variable is higher than the high set-point index, a **high** control load is energized to lower the measured variable. The band between the low and high set-point indexes is called the **normal** band and is adjustable from 0 to 100% of the total range of the instrument. If instrument contains a fixed band, the band is not adjustable from 0 to 100%.

C. How the Electronic Control Unit Works

The measuring element of the instrument is connected to a differential mounting to actuate the pen or pointer and a vane. When this vane moves between two control coils, a change occurs in the electronic control circuit that actuates the control relay. The circuit is designed to have the control relay energized when the vane is out of the coils and deenergized when the vane is between the coils. A stop is provided on the differential mounting to prevent the vane from going completely thru the coils.

If a failure occurs in tubes or power supply to the instrument, the controller will operate as follows:

On L, H or LH controllers, the controller will operate as though the pen or pointer were above the set-point, L circuit open, H circuit closed (control relay deenergized).

On LOH or LNH Controllers:

1. If the low control unit fails and the high control unit is OK, the instrument will function as an "LH" controller.

2. If the high control unit fails and the low control unit is OK, the H circuit will close and the L and N circuit will open. This condition will remain until the fault has been corrected.

3. If both control units fail, operation will be the same as in 2 above.

Attachments for Single-Case Program Controllers

H17AX - End of cycle switch.
H17BX - End of cycle switch and signal lights in door.
H17CX - End of cycle switch, signal lights in door, and switch in door to start and stop cam motor.
H17DX - Signal lights and switch in door.
H17EX - Alarm switch, D.P.D.T. Relay, Red signal light and Push button switch in door.
V18C - Internal set-point adjustment, permits adjustment of cam follower (set-point) anywhere within range limits.
G76 - Cam Switch on Right, Chart Switch on left and Terminal Block with Two Extra Points, 1 each wired to hot side of each Switch.
V34X - Friction Device to eliminate backlash.

Attachments for Two-Case Program Controllers

G1 - Toggle switch inside of case.
G3 - Toggle switch, red and green lights in door of cam case of two-case program controller.
H1 - End of cycle switch, combined with On-off toggle switch and the red and green lights in the door of the cam case.
H2 - End of cycle switch, combined with red and green signal lights in the door of the cam case.
H3 - End of cycle switch for two-case program controller.
V18A - Same as V18C except used on two-case program controllers having 1 cam, 1 control.
V18B - Same as V18A except for controllers with 2 cam, 2 control.
Z47AX - Explosion Proof Cam Drive.

D. Single-Case Program Controllers

1. Non-indicating, non-recording, one-cam, one control. All electric controls are available in this instrument. The door has a key hole for a cam setting key.

Attachments available: Red and Green signal lights, End of cycle switch, Toggle switch and an external knob for setting the cam, instead of a key. The toggle switch starts and stops the cam. Green light shows the cam is running. End of cycle switch operates at the end of the program, stops the cam and lights the red light. A special version of the single-case, non-indicating, non-recording program controller is equipped with a reversing type cam drive and with a hermetically sealed polarized relay that can be operated from a remote "raise lower" switch. When the "Raise" switch is pressed, the cam drives forward raising the set-point of the controller. When the "Lower" switch is pressed, the cam reverses and moves the set-point downscale. Both program and controlling sections are in one case.

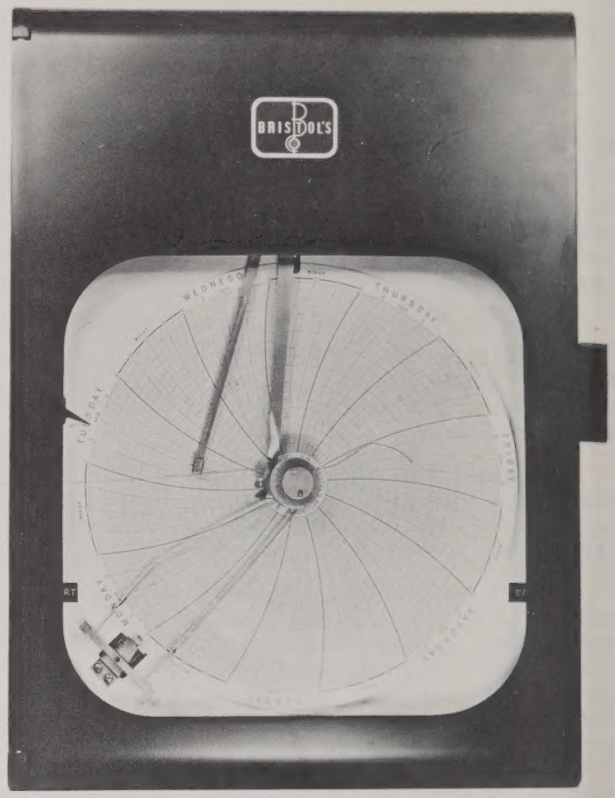


FIGURE 2. ONE-PEN, ONE-CAM, ONE-CONTROL, SINGLE-CASE RECORDING PROGRAM CONTROLLER.

2. One-pen recording, one-cam, one-control. The cam is driven through a center arbor. The chart is driven at the periphery. The drives are mounted separately on the chart plate and it is not necessary that they have the same rotation speeds. The cam is cut from clear plastic so that the chart record can be seen through it. An on-off switch inside the case starts and stops both cam and chart drive.

The set-point is shifted continuously by a cam follower sliding on a cam cut according to the desired program.

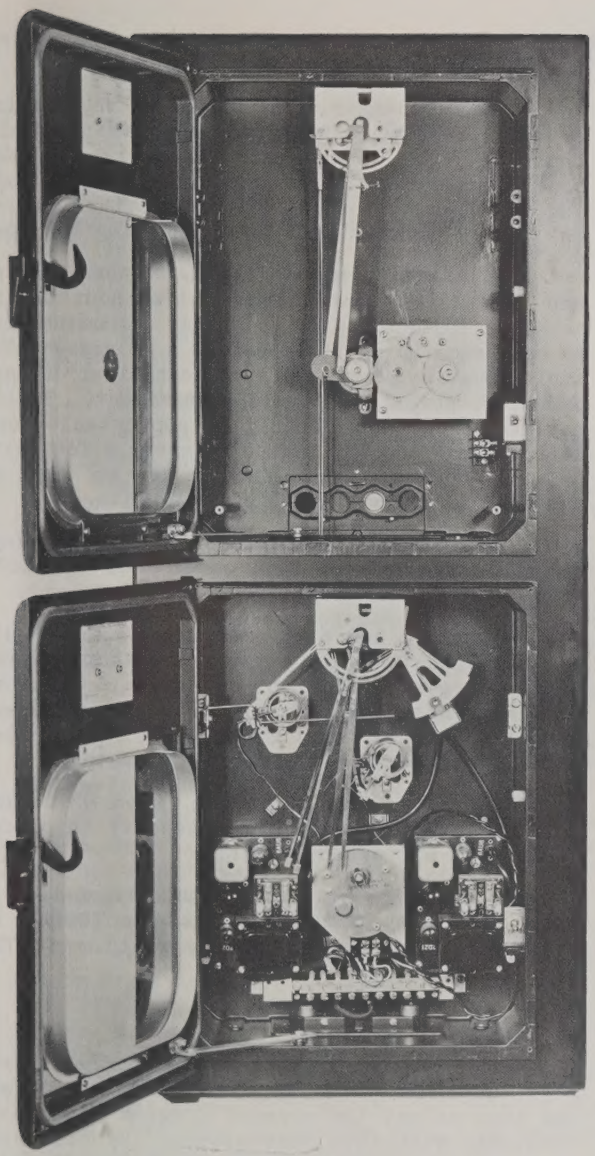


FIGURE 3. TWO-CAM, TWO-CONTROL, TWO-CASE RECORDING PROGRAM CONTROLLER, VERTICAL LINKAGE.

E. Two-Case Program Controllers

The Bristol Two-Case Program Controller is designed to control any measured variable, such as temperature, pressure, etc., by means of electronic control equipment built into the case. The two-case controllers are mounted on a panel with inter-connections as required.

The programming section is in one 12" series 500 case; and the controlling section is in a second 12" series 500 case. The cam-follower is linked mechanically to the set-point of the controlling section.

These units are furnished with "horizontal linkage" and mounted side by side on a steel panel; or with "vertical linkage" mounted over and under. Many variations of cam drives for the programming unit and chart drives for the controlling unit are available. The cam speed need not be the same as the chart speed, but both desired speeds should be specified on inquiries and orders.

The two-case instruments can be furnished with either one, two or three control units. In a one-control instrument, there is one cam and one recording-controlling system. In a two-control instrument, two cams are mounted on the same arbor, and driven by one cam drive. Each cam may have its own individual contour, but the speed of both cams is the same. In a three control instrument, two of the control units may be wired to provide LOH control on one pen and LH control on the other.

PART II INSTALLATION

A. Unpacking

1. Standard accessories. Every Bristol Program Controller is supplied with one of each of the following items:

(1) box of 100 charts, range and chart number as ordered.

(2) 1-ounce bottle of ink with dropper. Multiple-pen instruments get a 1-ounce bottle of different color ink for each pen supplied.

(3) pen cleaner wire (.005" diameter) with instructions in envelope.

(4) brass chart drive key (spring drive only).

(5) cams (as required).

The above parts are always packed with the instrument and are itemized with the packing list. Do not throw away the packing until everything has been located and identified.

2. Shipping Devices

a. Remove and discard the sponge packing support under pen arm.

b. Remove from under chart hub the circular instruction on the operation of Quick-set chart hub. Read this instruction carefully.

c. Remove cardboard which holds cam follower in place.

d. Remove red metal shipping device from differential pen mounting.

B. Mounting

Always mount the instrument vertically and level. Use a spirit level or plumb bob to check this.

1. Single Case Program Controllers (See fig. 2)

The controller may be mounted on a panel or wall. Universal mounting brackets are provided for either location. Choose a place as free as possible from dust, dirt, vibration, corrosive fumes and extremes of temperature.

2. Two-Case Program Controllers (See fig. 3)

The Two-Case programmer is shipped to the customer already mounted on a panel for convenience of installation. Four mounting brackets are supplied and are attached at each corner of the panel.

If customer so desires, both instruments may be removed from panel and mounted on customer's panel. However, a calibration check must first be performed before initial start-up of controller. (Refer to Service Section of this instruction.)

C. Measuring System

Note: The information below covers thermometer systems only. Separate instructions will be furnished as needed covering other types of measuring systems.

1. Description. The thermometer system consists of the element, connected by flexible tubing to a metal chamber or bulb. The bulb, tubing and element, form a sealed pressure system which is factory filled with a fluid dependent upon the class of thermometer system. Bristol Company thermometer systems are classified into four main categories and are in accord with the standards set by the Scientific Apparatus Makers Association:

Class 1 - Liquid filled systems
Class 2 - Vapor pressure systems
Class 3 - Gas filled systems
Class 5 - Mercury filled systems

This sealed pressure system must never be opened or broken because the filling will leak out, even thru the most minute crack or hole, making the system inoperative.

Pressure changes or expansion of the filling fluid occurs when temperatures at the bulb change. These changes are transmitted by the capillary tubing to the pressure element, causing the element to coil or uncoil, thus moving the pen or pointer thru the connecting linkage.

2. Installation of Tubing. Uncoil tubing and carefully straighten it out without twists or kinks. Do not cut it under any circumstances. Do not bend tubing at less than a 3" radius. The tubing must be protected from mechanical damage, crushing, abrasion, strain or movement. Tubing may be strung thru conduit or supported on any wall, beam, etc., by fastening every 2 feet with clips, staples, etc. Tubing may be tied or taped to unheated pipes, columns, etc.

Do not subject tubing covered with polyvinyl chloride plastic to temperatures over 160°F (71°C) or it will melt.

Class 1, 3 and 5 uncompensated tubing must be installed to avoid extremes of temperature. Keep tubing away from hot or cold pipes, ovens, chimneys, hot or cold air ducts, open windows, direct sunlight, etc. Class 2 tubing is relatively unaffected by ambient temperatures.

Coil any excess of tubing in an 8" to 12" coil near the instrument and tape it in place. **Do not cut off excess tubing.**

For those who wish additional information on thermometer systems, Instruction T8000A is available at ones request by writing to The Bristol Company.

D. Wiring

Before making any connections to the instrument, determine what type of control you have and then select the correct diagram from those furnished with this instruction. Special diagrams will be furnished when required. The name plate of the instrument shows what voltage and frequency are to be connected to the a-c power terminals. Note that there are terminals for either 120 volts or 240 volts. Be sure to use the correct terminals. It is suggested that all wiring to the instrument be put in conduit.

Rating of Control Relay Contacts. The relay contacts in the control unit are limited to a non-inductive capacity of 15 amperes at 120 volts, 25, 50 or 60 cycles, 6 amperes at 240 volts, 25, 50 or 60 cycles, and 0.4 ampere at 120 volts d-c.

PART III OPERATION

A. Method of Cutting Metal Cams

1. General

a. Note that curved time lines printed on cams may curve one way or the other as illustrated in figures 4 and 5. Select, as a working example, that figure similar to the cam being cut.

b. Metal cams may be easily cut with ordinary tin shears.

2. Marking Time Schedule on Metal Cams

a. All cams used on Series 500 Program Controllers rotate in a counterclockwise direction. In laying out the time schedule, always proceed in the opposite direction of the cam rotation.

b. Note time required for one revolution of cam. This may be found on face plate of cam-driving mechanism and nameplate of the instrument. Count number of time intervals printed on cam and determine number of minutes or fraction of an hour corresponding to one time interval. (Examples are given below.)

3. Marking of Cam to Compensate for Radius of Cam-Follower Roller.

a. For a uniform temperature rise, compute number of degrees per time interval and mark cam accordingly in a dotted, smooth curve. A sharp pencil is satisfactory for marking a temperature curve on a metal cam.

b. After dotted line has been laid out, a pair of dividers may be used to scribe a solid line 3/32" inside the dotted line as shown in figures 4 and 5. Cut cam along this solid line. This compensates for radius of cam-follower roller. Any irregularities may be smoothed out by means of a small file. If the rate of rise critical the edge of the cam should be smoothed by a fine emery cloth or crocus cloth.

c. Example A. See Figure 4.

Time required for one revolution of cam: 6 hours or 360 minutes.

Number of time intervals printed on cam: 180

Time corresponding to one interval: 2 minutes

Raise temp. to 90°F in 10 min.
Hold temp. at 90°F for 60 min.
Raise temp. to 210°F in 60 min.
Hold temp. at 210°F for 60 min.
Lower temp. to 200°F
Hold temp. at 200°F for 20 min.
Raise temp. to 210°F for 6 min.
Hold temp. at 210°F for 60 min.
Lower temp. to 200°F
Hold temp. at 200°F for 20 min.
Temperature drops: End of schedule

d. Example B. See Figure 5.

Time required for one revolution of cam: 12 hours or 720 minutes

Number of time intervals printed on cam: 144

Time corresponding to one interval: 5 minutes

Raise temp. to 70°C in 40 min.
Hold temp. at 70°C for 60 min.
Raise temp. to 110°C in 80 min.
Hold temp. at 110°C for 60 min.
Raise temp. to 150°C in 40 min.
Hold temp. at 150°C for 120 min.
Lower temp. to 70°C in 80 min.
Hold temp. at 70°C for 45 min.
Lower temp. to 50°C

4. Marking of Cam Without Compensation for Radius of Cam-Follower Roller

If a small error or discrepancy between the program cut on the cam and that duplicated by the controller is not objectionable, the undercutting of the cam mentioned in the previous paragraph can be dispensed with.

These errors will be as follows:

Time error ± 2% max. to zero min.
Measured variable error + 2% max. to zero min.

This does not mean that the controller or the record will be incorrect, but merely that the actual program produced will differ from that cut on the cam.

5. Maximum Rise

It is obvious that too steep a rise in the cam would require considerable power in the cam-driving mechanism. The geometry of the cam drive is such that the drive is capable of overcoming a rate of rise on the cam which is a minimum at the center of the chart and a maximum at the outside. This means that the cam curve that will change the follower from zero to 100% of scale in the shortest period of time, is one which will have an increasing rate of rise.

There are several factors which determine the maximum rate of rise such as weight of links, one or two cams, etc.

Included with this instruction are drawings outlining full scale templates to be used in checking any particular cam rise. (The electric drive produces more torque then the spring wound and hence will pull over a steeper rise.) Refer to drawing nos. 018689 and 018691.

When a template is cut out, it should be rotated around the cam center to see that the slope on any portion of the program outline does not exceed the rise represented by the reference edge of the template.

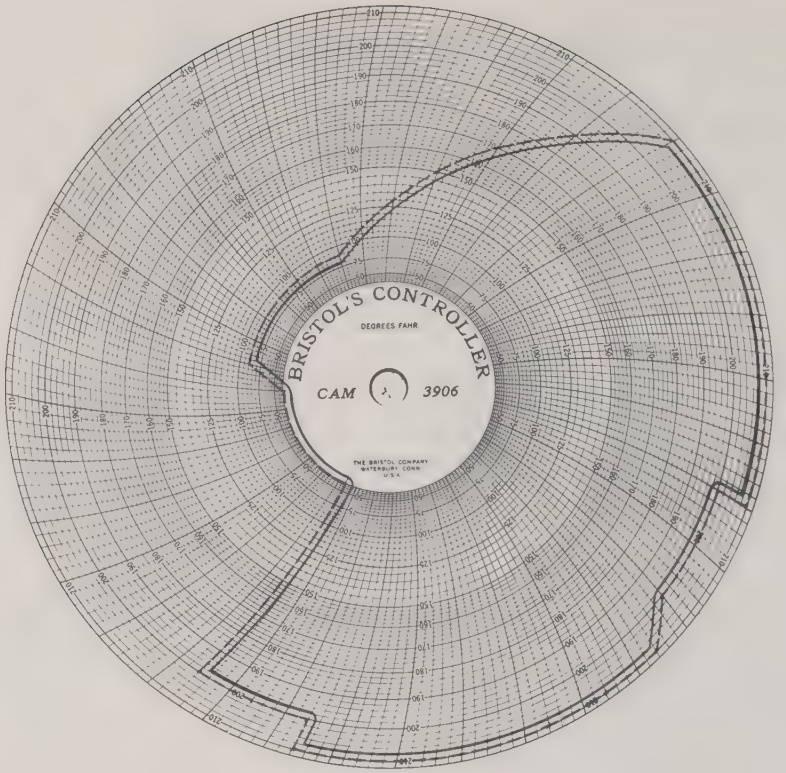

BRISTOL'S CONTROLLER
DEGREES FAHR
CAM
3906
THE BRISTOL COMPANY
WATERBURY, CONN.
U.S.A.

FIG. 4

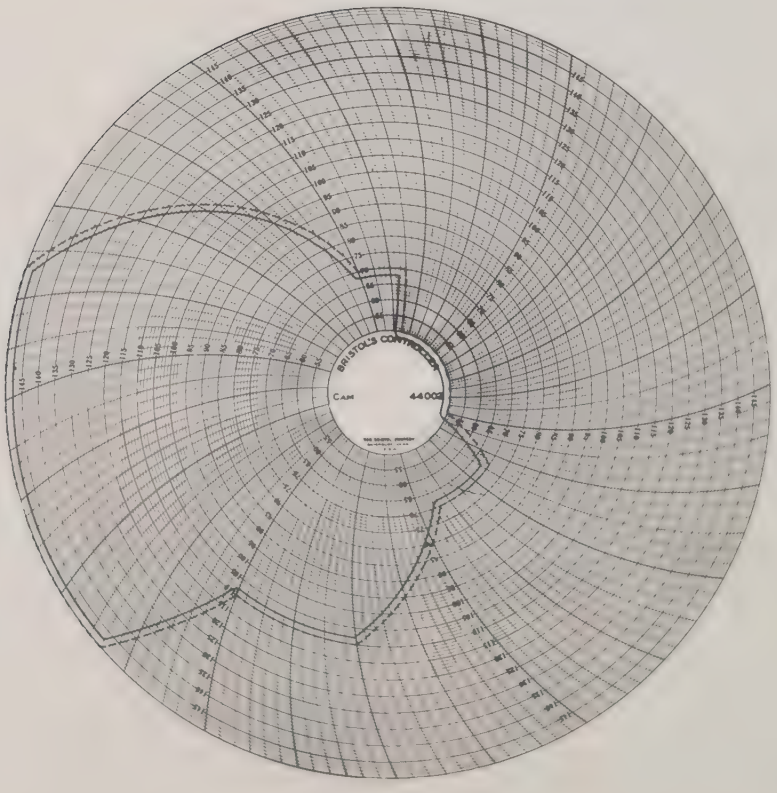

BRISTOL'S CONTROLLER
CAM
44002

FIG. 5

6. Two-Cam Controller

On controllers with two cams, it is sometimes desirable to pin the cams together in order that the cams will always have the same relationship with each other.

After the cams are properly cut, remove the cam hub from the instrument. Next, remove the pin that is screwed into the hub. Place cams on the hub in the required relationship.

With a #46 (.081") drill, drill a pilot hole thru both cams using the hole, from which the pin was removed, as a guide. Then, remove the cams and enlarge the hole in each cam with a #38 (.1015") drill.

Replace pin in hub and replace hub on instrument. Replace cams using pin as a guide for proper placement. As the cams cannot be put on but one way, that is with pin through hole, this assures that the cams will always be in the same relationship with each other.

7. Blank Cam

In case a blank cam is furnished, a paper chart may be pasted on the blank cam and the cam then cut as per above instructions.

8. Schedule Records

It is advisable to enter each different time-program cam schedule on a card which is numbered and filed for convenient reference. The card numbers may be marked on the corresponding cams and the cams filed numerically.

B. Method of Cutting Transparent Cams

1. How to Cut Transparent Cams

a. Transparent cams may be cut with a band saw and then filed smooth. It is first necessary to outline in pencil on a chart the particular program desired. There is a limit to the amount of rise at any particular point on the chart.

b. A drawing is provided with this instruction, outlining a convenient template to be used in checking any particular cam rise. This template may be cut of transparent celluloid or other transparent material, or of necessity may be used as is.

c. When the template is cut out, it should be rotated around the chart center to see that the slope on any portion of the program does not exceed the rise represented by the reference edge of the template.

d. When a rate of rise greater than that of the template is required, the Bristol Company Engineering Department should be contacted.

e. After the program outline has been correctly drawn on the chart, place the transparent cam over the chart, making sure to center the cam over the chart. With any pointed instrument, scribe the outline of the program on the cam. Then cut the cam on a band saw as close to the scribed line as practical and then file the balance smooth to the exact program line.

C. How to Start Controllers

After cams have been properly cut and installed proceed as follows.

1. Turn instrument power supply on and allow approximately 60 seconds for tubes to warm up.

2. Move set-point index or indexes to the desired value on the chart or scale by rotating the cam, positioning the cam follower which in turn positions the set-point index.

3. Turn load circuit power supply on. Instrument will then begin automatic control.

D. Checking and Adjusting the Control Point

The actual control operation of an electronic controller is accomplished when a vane enters a limited space between two coils, thereby altering a magnetic field which generates an electric signal which results in the operation of a relay. Electronic controllers should be checked to see that the relays operate at the proper relationship between the pen and the control index. This can be done in the following manner.

1. The links between the elements and the differential pen mounting should be first disconnected. (Disconnect at pen mounting.)

2. Rotate the cam until the cam follower roller rests at the lowest portion on the cam. The set-point index on the electronic controller should then be resting on the corresponding line of the chart. Manually move the pen, corresponding to the particular control system, (all systems are color coded) slowly until it is aligned with the tip of the set-point index. The relay should actuate when the pen passes the tip of the set-point index. The relay actuation can be detected by an audible click. Be sure that the correct pen is checked with the correct set-point index. Check the red pen with the red set-point index and the blue pen with the blue set-point index. Rotate the cam so the cam follower rests at the middle of the range cut on the program cam and check the operation of the relay as previously described.

Repeat this process with the roller of the cam follower on the upper most portion of the range cut on the cam.

3. If the relay does not operate when the pen passes the tip of the set-point index, and the error in the position of the pen with relation to the set-point index is all in one direction at all three points on the chart, the correction can be made two ways.

a. There is a control-point adjustment located on the electronic unit (see Figure 1). Turning this control-point adjustment either to the left or right, depending upon the direction of correction, will bring the operation of the relay into alignment with the tip of the set-point index, providing the error is not more than two lines on the chart (item 14, fig. 1).

b. There is also a micrometer adjustment on the base of the freevane itself. This micrometer adjustment will alter the position of the vanes, thereby changing the point at which the vanes will cut between the coils and actuate the relays. This adjustment is preferable to the control-point adjustment in the electronic unit (item 11, fig. 1).

E. Checking and Adjusting the Differential Gap

Differential gap (dead zone) applying to two-position controller action (LH control) is the smallest range of values thru which the controlled variable must pass in order to move the final control element in succession to both of its fixed positions. This zone is set at the factory at approximately .003" and seldom requires readjustment. However, when the instrument is subject to excessive vibration, it may be necessary to widen the differential gap in order to prevent erratic operation of the controller.

To check the width of the differential gap, move the set-point index slowly past the recording pen (both upscale and downscale) and note when the control relay operates. If readjustment is required, it may be done by adjusting the differential-gap adjustment (item 13, fig. 1) with a fiber screwdriver. Turn the adjusting screw counterclockwise to widen the differential gap or clockwise to narrow the gap. Check the control point after any change in the differential gap.

F. Chart Drives

1. Single-Case Only

The chart drive used on single-case program controllers is a friction-type chart drive powered by a 3-watt, self-starting synchronous motor, which depends for timing on the frequency of the alternating-current supply. Therefore, the frequency must be exactly as listed on the nameplate in order to obtain accurate chart timing. A supply voltage variation of plus or minus 10% or less will not affect accuracy of timing. Electric chart drives will restart automatically after power failure, but lost time must be made up by manually advancing the chart until the correct time division is indicated by the time index on the left-hand side of the chart plate.

The chart drive motor is mounted behind the chart plate and its friction drive wheel makes contact with the chart thru a slot in the left-hand side of the chart plate. A nylon roller, mounted on a spring bracket, exerts pressure against the friction drive wheel only when the hub is pushed in against the center arbor.

2. Two-Case Only

The chart drive in a two-case program controller is mounted in the controlling case. Two types of chart drives are available, they are spring and electric. All Bristol chart drives for round chart recorders have identical mountings and are, therefore, interchangeable. Thus, chart rotation time or voltage and frequency used can be quickly changed. Spring and electric drives are also interchangeably mounted.

a. Service Chart Drives. All Bristol Branch and Main Factories carry stocks of carefully rebuilt, fully guaranteed spring and electric chart drives which will be exchanged for the same specification defective drive for a nominal charge. In order to positively identify correct speed, gear ratio, voltage and frequency etc., we must receive your old chart drive before shipping the replacement service drive.

Instrument users having several Bristol recorders would do well to keep one or two chart drives in stock as universal standby replacements.

b. Spring Chart Drives

1. How to Wind. With chart removed, insert brass key thru hole in chart plate and wind arbor clockwise as far as it will turn. Wind all 7 and 8 day spring chart drives once each week. All other drives must be wound once each day.

2. Adjusting Speed. If chart revolves too slow or too fast, the speed of the chart drive should be adjusted by turning adjusting lever in the direction required. Moving the lever clockwise makes the drive go faster and moving the lever counterclockwise makes the drive go slower. The cap must be removed to get at the adjusting lever.

c. Electric Chart Drives (Most commonly used on program controllers). Electric chart drives are powered by a 4-watt, self-starting synchronous motor which depends for its timing on the frequency of the alternating-current supply. Therefore, the frequency must be exactly as listed on nameplate to obtain accurate chart timing. Where frequency is unregulated, the Bristol Company recommends use of spring chart drives.

Most recorders require power supply wires to be connected directly to the terminal block on the chart drive.

Caution: Before connecting power wires to chart drive, be sure to check on chart drive facing for correct voltage and frequency.

A supply-voltage variation of plus or minus 10% or less will not affect accuracy of timing.

There is no starting knob or speed regulator on electric chart drives. Electric chart drives will start automatically after power failure, but the lost time must be made up by manually advancing the chart to correct time.

G. How to Change Charts

1. On Single Case Only

a. Pull the knurled knob on center arbor out and swing hub and cam out of the way.

b. Remove used chart and slip new chart on center arbor and under time index and rotate chart to proper time.

c. Push hub back on arbor and rotate hub until it falls into keyways on arbor and then press hub tightly against chart.

2. Two Case Only (See Fig. 6 and 7)

a. Push pen lifter down in order to hold pens and pointers away from chart.

b. Tip up Quickset chart hub and slip off the old chart.

c. If instrument has a spring chart drive, wind chart drive by inserting brass key thru hole in chart plate.

d. Slip new chart over chart hub, under slot in chart plate and under time index. Turn chart by hand until time index points to correct time. Note: Pens on multiple-pen recorders, in order to pass each other, cannot all swing on the same time arc of the chart. Therefore, the time index on such recorders is adjusted to indicate the time difference between pens when reading chart records made by multiple-pen instruments.

e. Turn chart hub down and push firmly on its curved end in order to hold chart.

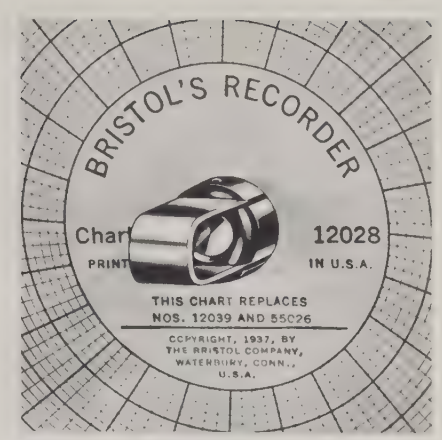


FIGURE 6. QUICKSET CHART HUB - OPEN.

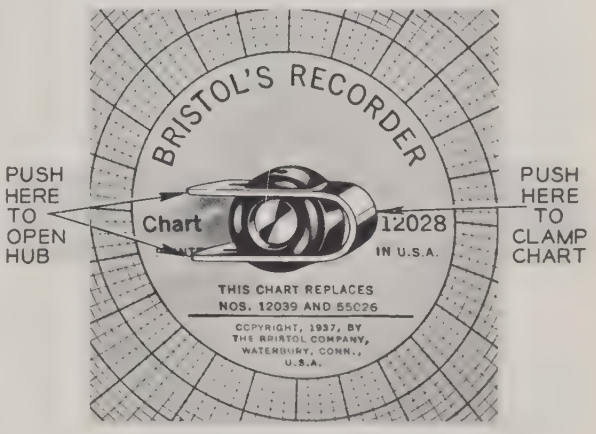


FIGURE 7. QUICKSET CHART HUB - CLOSED.

J. How to Install or Change Cams

Unscrew knurled nut on center arbor. Place cam on arbor and rotate cam to proper starting point. Replace knurled nut and screw tightly to hold cam in position.

K. How to Change Cam Speeds

When so ordered, this instrument can be provided with extra gears or motors to provide a wide range of cam speeds. Refer to the parts list for the listing of available speeds, motors and gears.

1. How to Change Gears (refer to Figure 8).

a. Loosen screw item 1.

b. Remove screw item 2 and change gear B.

c. Remove gear A after first loosening its setscrew.

d. Install new gear A and tighten its setscrew.

e. Install double gear B on adjustable plate and shift plate until gear B meshes properly with both gear A and C. Tighten screw item 1 after adjustment. Gears should mesh neither too tightly nor too loosely.

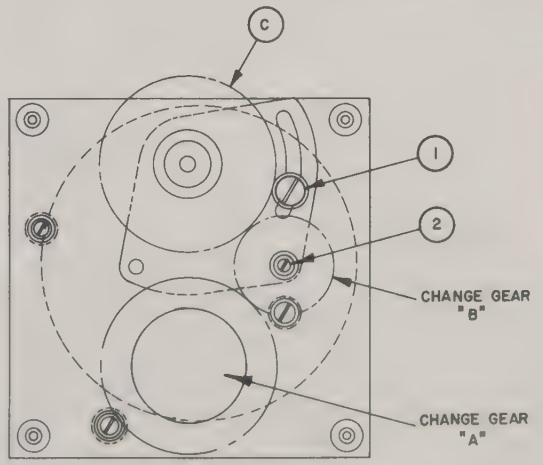


FIGURE 8. CAM DRIVE AND CHANGE GEARS.

L. Pens

1. Single-pen Recorders. Single-pen recorders are supplied with standard fountain pens.

2. Multiple-pen Recorders. Multiple-pen recorders are supplied with capillary tips of different lengths so that they may pass each other on the chart. The pen nearest the chart is called the no. 1 pen, the next pen is called the no. 2 pen. Be careful not to bend pens (or pen arms) of multiple-pen recorders as they must pass each other without touching.

All pens should be replaced as soon as the tip is worn, broken or corroded.

3. How to Ink and Start Pens. Pens, as supplied, usually will hold more than enough ink for one complete chart revolution. However, it is wise to refill pens every time the chart is changed.

a. Fountain Pen. Fill fountain pens to the top, using dropper from ink bottle. Standard pens take about 3 drops of ink. If pen fails to trace when lowered on chart, try touching tip of capillary tube with a moistened finger. If pen still fails to trace, pull pen off pen arm and squeeze between thumb and finger, then dip end of capillary tip in a drop of ink and release pressure of fingers. Replace pen by pushing pen all the way up on forked end of pen arm.

Use the 1-ounce bottle and pen filler furnished for re-inking pens. Inks are available by ordering from The Bristol Company.

M. Pen Arms

Pen arms for the 1st and 2nd pens of multiple-pen recorders are of different lengths and, therefore, are not interchangeable.

All Bristol pen arms are identified by code letters stamped into their upper ends. Be sure to specify these code letters from your old pen arm when ordering replacements.

Do not bend pen arms. If the effective length of the pen arms is altered, the pen will not swing along the time arc on the chart and, therefore, will not record the measured variable correctly. If pen arms of multiple recorders are bent, they will not pass each other freely.

N. Ink

1. Standard Color Code. The color of ink to be used in each pen of multiple-record instruments is painted on its pen arm or base end.

2. Standard Ink. Standard Bristol recorder ink will perform well at internal case temperatures form +10°F to +160°F(-12.22°C to +71.11°C).

3. Low-temperature Ink. Bristol low-temperature ink is recommended for case temperatures from -65°F to +80°F (-54°C to +26°C). It will flow evenly and will not freeze at these temperatures.

4. High-temperature Ink. Bristol high-tempetature ink is recommended for case temperatures from +60°F to +500°F (+15°C to +260°C). This ink will not dry in pens or boil away when used between these temperatures.

5. Quick-Drying Ink. This type of ink is recommended with high speed charts (15-, 30- and 60-minute rotation) because it dries quickly and permits charts to be removed immediately when finished without smearing the record.

Quick-drying ink is also recommended where high humidity conditions exist.

Note: Use only Bristol recorder inks. Ordinary inks dry too fast, clogging and corroding pens.

PART IV SERVICE

A. Checking the Tubes

If your controller fails to function properly and there is no obvious fault (such as power failure, measuring-element failure, etc.), check the electronic tubes by replacement (a spare set should always be kept on hand). Remove one tube at a time from the control unit and replace it with one known to be good. Allow 60 seconds for the tube to warm up. When operation is restored, the original good tubes may be reinstalled. If normal operation is not obtained with a complete new set of tubes, the control unit should be replaced with one known to be good. When replacing a unit, leave the old tubes in the old unit.

Note: The vacuum tubes used are standard types and may be purchased in any radio supply store.

B. Replacing a Control Unit

To remove a control unit, disconnect the wires connecting the unit to the terminal block and remove the plug-in cable from the control coils. After removing the mounting screws, the unit may be easily removed from the case. Install the new unit, replace and tighten the mounting screws and connect the wires as per wiring diagram.

After the new unit has been installed, check its control point and differential gap as outlined in Part III Operation, paragraph D & E.

C. Service of Relay Contacts

The relay contacts should be cleaned and burnished (with crocus cloth) as often as experience shows it to be necessary.

D. Inking System

1. General. The final chart record can only be as good as the material used in the production of the record. These include ink, pens and chart paper. The ink must be of good quality. It must be free from free floating material and contamination. Ink that is properly suited for normal recording should dry as soon as the ink penetrates the paper. Under normal conditions the ink will be smearproof.

The Bristol Company manufactures in its own lab, all of the ink used in Bristol instruments. The inks used with Bristol recorders are made to cover a wide range of temperatures as described in Part III, paragraph N. Ink supply bottles should be kept tightly capped to prevent contamination. Ink bottles should not be stored in abnormal temperatures.

2. Cleaning of the Inking System. Pens should be cleaned periodically to forestall trouble because only a clean pen can record a clean record.

To clean pen, loosen screw holding pen arm and pull pen arm and pen off of base end. Wash pen in warm water.

When necessary, clean out capillary tip of fountain pen by inserting pen cleaner wire which is supplied with instrument.

Replace pen arm and pen, being sure to push prongs of pen arm up under rivets on base end until it snaps into place. Retighten locking screw.

E. Checking and Calibrating

1. Testing for Friction. Be sure to eliminate all friction before attempting to recalibrate any thermometer system. Under bad conditions of high humidity, corrosive fumes, gum forming vapors, dust laden air, etc., a possible reason for loss of calibration is corroded or dirty bearings in the thermometer system.

a. Overall Test for Friction. This test should be made before checking or calibrating.

Immerse bulb in test bath and allow pen or pointer to come to a final reading undisturbed. While watching pen or pointer closely, gently tap instrument case. If pen or pointer jumps to new position, there must be friction somewhere.

b. Test for Element Shaft Friction (Refer to Figure 1). With fingers, gently move friction disk assembly (item 3, fig. 1) in and out. There should be a small amount of end play and the bearing should slide very freely on the shaft. If the bearing does not slide freely on the shaft, take the bearing apart without disturbing length of lever or adjustments 5, 6, 8 or 10. To take bearing apart, remove locking screws 3, slip top plate and lever arm off pedestal plate, remove element mounting screws and slip element, together with bearing, off shaft. Clean bearing and shaft with cleaning fluid. If bearings are corroded polish gently with crocus cloth.

Check also for friction in all control links, levers, bearings, vanes, etc., which are moved by the thermometer element.

c. Pen Pressure. Considerable friction can result if the pen point bears too heavily on the chart. With fingers, bend pen arm until pen touches chart with just enough pressure to trace properly.

2. Cautions for Calibration or Checking

Be sure thermometer case is exactly level.

Use test thermometer with a range close to that of the thermometer being tested.

Use a recently tested test thermometer with an accuracy of 1/2% or better.

Make readings only from actual pen tracings quickly obtained by loosening the chart hub and turning chart slightly by hand.

3. Checking and Calibrating Procedure. See Figure 1. Thermometers may be checked while installed or may be removed to the shop or instrument laboratory. It is best to calibrate while installed for the following reasons:

a. Saves time and handling of easily damaged tubing.

b. Automatically corrects for existing ambient temperatures along the tubing at the case.

c. Automatically corrects Class 2 and 5 thermometers for difference in bulb and case levels.

Mechanical Alignment. This step should be necessary only if the length of link or the coarse zero adjustment have been disturbed. Mechanical alignment adjustment places all links and levers in correct geometrical relation so as to minimize angularity errors.

Remove chart and chart plate and prepare a cutaway chart such as that illustrated in Figure 9. Paste cutaway chart on stiff cardboard for support and install on chart hub with chart positioned so as to give access to linkage.

Next, place bulb in test bath maintained at a temperature equivalent to mid-scale value. Link 9 should be at right angles to the driven arm at upper end of link 9. If right angles do not exist at these points, loosen locking screws 8, alter length of link 9, and shift position of link 9 until a right angle exists. Retighten locking screws after any adjustment.

Three adjustments, used singly or in combination, are employed in calibrating any link type instrument. These are point, span and linearity correction.

1st. Point Adjustment (also called zero adjustment). The point adjustment shifts the entire scale up or down the same amount. It changes the base point without changing the slope of the curve or its shape.

The point adjustment is usually made by means of the micrometer adjustment on the measuring element (item 10, fig. 1).

The coarse zero adjustment is made at the center of rotation of the element by means of a friction plate (held by locking screws, (item 3, fig. 1).

2nd. Span Adjustment (sometimes called range or scale length adjustment). Starting at the base point, a span adjustment will progressively increase or decrease readings over the remainder of the scale. It changes the slope of the curve without changing the shape or the base point. A span adjustment is made at micrometer adjustment 6. Lengthening the effective length of arm 4 increases the amount of pen travel; shortening it, decreases amount of pen travel. After making a span adjustment, always recheck zero. These checks should be made as often as necessary until both adjustments are correct.

3rd. Linearity Adjustment. A linearity adjustment changes the slope of the curve. If lever arm 4 pushes on link 9 for increasing values of temperature; lengthen link 9 to increase motion in the top portion of the scale or shorten link 9 to decrease motion in top portion of the scale. If lever arm pulls on link 9 for increasing values of temperatures; shorten link 9 to increase motion in the top portion of the scale or lengthen link 9 to decrease motion in the top portion of scale.

Step 1. Point Check and Calibration. Remove bulb from application. Run thermometer up and down scale 3 or 4 times before checking readings, especially if system has been out of service for some time, by immersing bulb alternately in cold and hot test baths.

Place an armored, glass-stem test thermometer, with an accuracy of 1/2% or better, alongside bulb so that the two bulbs are as close together as possible and then tie them together with string.

Immerse bulb and test thermometer in a test bath at a temperature corresponding to a 10-20% reading on the instrument scale or chart.

Stir test bath vigorously with a paddle for at least 3 minutes each time before taking readings. Never stir test bath with bulb itself. If possible, read test thermometer without removing it from the test bath and while continually stirring. The set-point index must be in line with recording pen before taking reading at any check point.

Quickly compare chart or scale reading with that of the test thermometer. If pen or pointer do not read correct value, adjust point adjustment 10 on element. Recheck readings carefully. This completes the point calibration.

Step 2. Span Check and Calibration. It will be necessary to remove the chart plate to reach the span adjustment. To avoid inconvenience of repeated removal and replacement of the recording chart and chart plate between each test reading, prepare a cutaway chart from thermometer being calibrated as per Figure 9. Paste cutaway chart on stiff cardboard for support. During calibration, remove chart plate and use this cutaway chart held by chart hub.

Immerse bulb and test thermometer in a test bath at a temperature corresponding to 80-90% reading on the instrument scale or chart. If pen or pointer does not read correctly, adjust span adjustment 6 by lengthening or shortening the effective length of driving lever 4. Lengthening the effective length of lever 4 increases the amount of pen travel; shortening it, decreases amount of pen travel.

Alternately, repeat point and span adjustments until thermometer is correct at both points. If after making above adjustment, it is found that the point adjustment 10 does not provide sufficient adjustment to bring pen to the test value of 10-20% of instrument range, then the coarse zero adjustment at the center of rotation of the element (item 3, fig. 1) will have to be used.

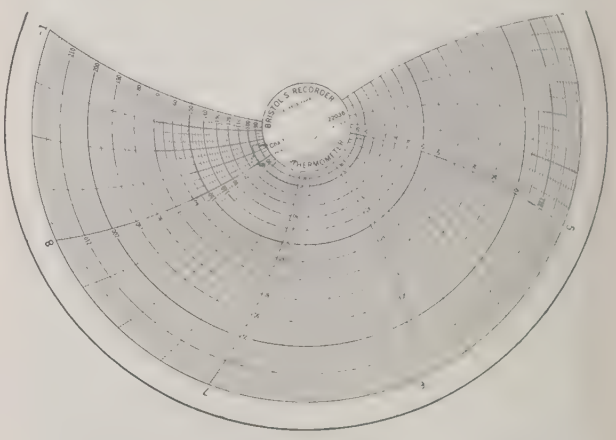


FIGURE 9. CUTAWAY CHART FOR USE IN CALIBRATION.

Step 3. Linearity Check and Calibration. After performing steps 1 and 2, until proper calibration is obtained at both the low end and top end of the scale range, check several intermediate points over the scale range. If a linearity adjustment is necessary, change the length of link 9 as required. If length of link 9 is changed, it will be necessary to check the mechanical alignment again as outlined above, as well as repeating steps 1 and 2 above, until proper calibration is obtained.

Note: The controller set-point indexes must always be adjusted after pen or pointer adjustment is changed.

4th. Calibrating Temperatures. If only a point check and calibration is made, it is obviously wise to select a test bath temperature close to working range of the thermometer.

F. Replaceable Thermometer Systems

All Bristol filled type thermometer systems are so made that entire temperature systems can be exchanged or replaced in the field without disturbing its calibration to any extent. New factory calibrated thermometer systems can be ordered from Bristol at any time. Factory made replacement systems are calibrated and tested in a standard recording thermometer, then removed without disturbing the calibration. The systems are then packed and shipped ready for easy installation in the field.

1. Changing Ranges. An important feature of Bristol thermometers is that thermometer systems of any range or any class can be interchanged without drilling or extra parts. Another feature is that a thermometer can be changed to a gauge by replacing the thermometer system with a pressure gauge system.

2. Standby Thermometer Systems. Users having a quantity of Bristol thermometers will find it advantageous to stock one or two calibrated thermometer systems of each range used, for quick replacement in case of damage to or failure of a system. Standby thermometer systems should be ordered with tubing long enough for any existing installation and equipped with a Bristol universal bulb for ready adaptation to almost any bulb installation.

3. How to Remove Thermometer Systems (See Fig. 1). Systems to be exchanged, repaired or replaced should be removed as follows:

Remove bulb from the process. Dismount tubing, coil and tie it, being careful not to cut, twist or kink it.

Remove case fitting, which holds tubing, from the split connecting plate. Do not allow weight of the coil of tubing to hang by the delicate capillary.

Disconnect lower end of link 9 from span adjuster 6 by lifting and swinging aside tab. **Do not** loosen screw 5 or disconnect top bearing of link 9.

Dismount element bracket by removing 2 screws (item 2, fig. 1) which hold it to the back of the case.

Remove entire thermometer system as a unit including element, element mounting, span adjuster, tubing, case connection fitting and bulb.

4. How to Install Replacement Thermometer Systems. Carefully unpack replacement system. **Do not** disturb any of its adjustments.

Install element using the mounting holes indicated on the tag attached to the new element. Install the connecting link between the span lever arm and the pointer shaft lever arm. The pointer lever arm has six useable holes. The proper hole to use is indicated on the tag attached to the new element (tag form 4140).

When completely installed except for the bulb, perform a point check at working temperature as instructed in Step 1. If span adjuster has not been disturbed, the thermometer should be in perfect calibration.

5. How to Order Replacement Thermometer Systems. Order replacements from the nearest Bristol Branch Office, giving the serial number and the chart number of your instrument as listed on the name plate inside the door. If ordering a system not exactly like your existing one, be sure to specify the new range and new chart number desired, or new bulb number, union or socket thread size and length of tubing. If changing range, don't forget to order a stock of the charts.

G. Set-Point Index Calibration (Two-Case Only)

Whenever a new measuring system is installed or the old one recalibrated or otherwise changed, the set-point index adjustment must be checked.

1. Place the cam follower at a point on the cam which represents the lowest portion of your program. The set-point index should now indicate the lowest portion of your program on the chart. (Note amount of misalignment if any.)

Repeat this step for cam positions corresponding to 50% and 100%, (also note the amount of misalignment at these points if any). If any misalignment is evident, use the zero adjustment screw on cam follower to reset the index pointer. Any non-linearity of the tracking between the cam follower and set-point index may be compensated for by adjusting the length of the link connecting the two cases. If a span adjustment is necessary, then adjust the lever arm located up under the cam follower mounting.

H. Repairs, Correspondance and Shipping

If your electronic program controller cannot be repaired with the information furnished in this instruction, it should be shipped to the nearest Bristol Company Branch or Main Factory for repair or replacement. Do not ship instrument to Branch Office.

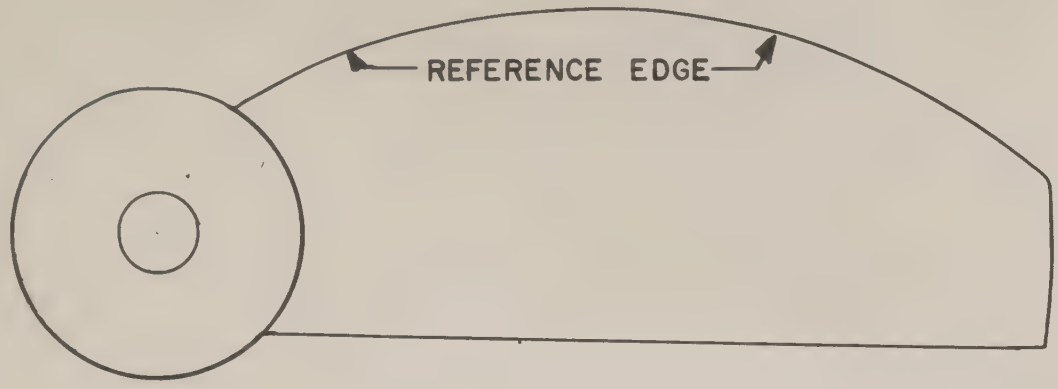
Send all parts for repair or exchange to Branch or Main Factories only, never to Branch Offices, identify your shipment fully, including your exact return address and repair order number.

Send all correspondance and orders to the nearest branch office. Addresses and phone numbers of Bristol's field organization are listed on last page of all instruction books.

Be sure to state model and serial number of instrument in all orders and correspondance.

Printed in U.S.A.

NOTE: THE SLOPE OF ANY CAM RISE SHOULD ALWAYS BE WITHIN THE SLOPE REPRESENTED BY THE REFERENCE EDGE OF THE TEMPLATE



NO. 018689

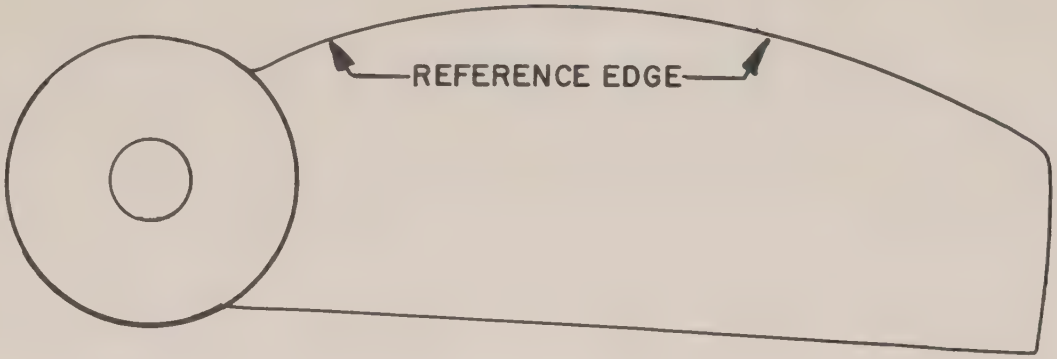
TEMPLATE FOR MAXIMUM RISE OF CAM ON TIME PROGRAM CONTROLLER IN THE SERIES 500 CASE WITH SPRING CAM DRIVE

DRAWN REW	DATE 12-20-60
TRACED	CHECKED / APPROVED
SCALE	FILE DRJ 21
NO. 018689	

REVISIONS

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

NOTE: THE SLOPE OF ANY CAM RISE SHOULD ALWAYS BE WITHIN THE SLOPE REPRESENTED BY THE REFERENCE EDGE OF THE TEMPLATE.



NO. 018691

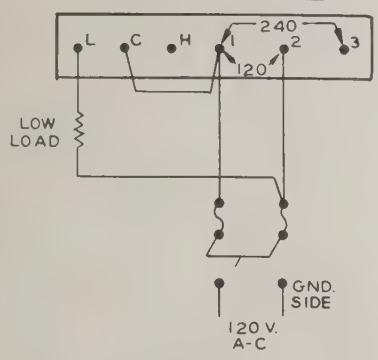
TEMPLATE FOR MAXIMUM RISE OF CAM ON TIME PROGRAM CONTROLLER IN THE SERIES 500 CASE WITH ELECTRIC CAM DRIVE

DRAWN REW	DATE 12-20-60
TRACED	CHECKED / APPROVED
SCALE	FILE DR. 21
NO. 018691	

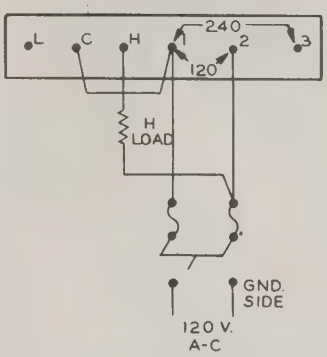
REVISIONS

THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

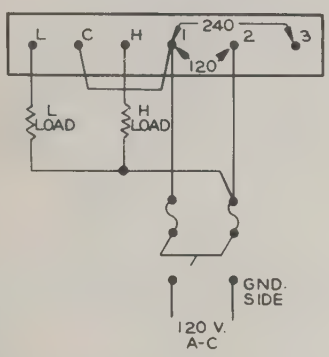
L-TYPE CONTROL



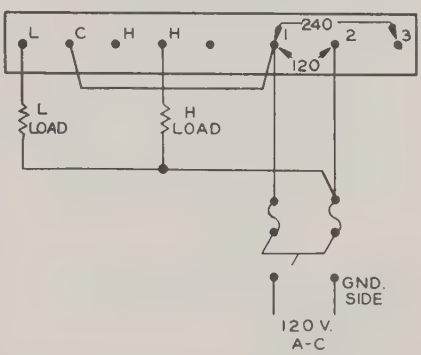
H-TYPE CONTROL



LH-TYPE CONTROL



LOH-TYPE CONTROL



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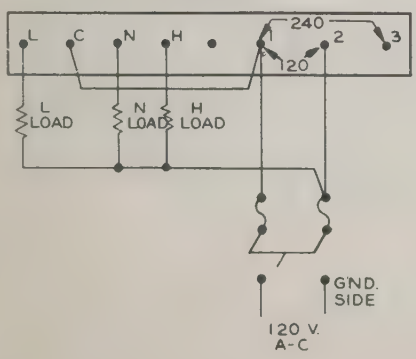
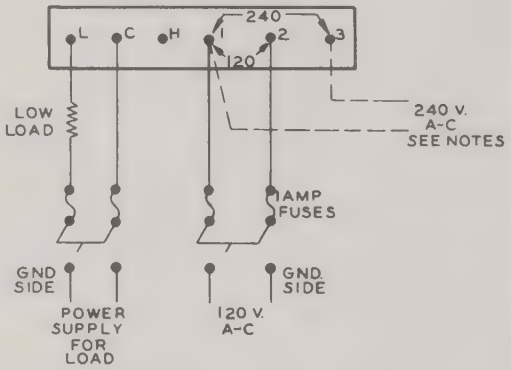


NOTES:-
1. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
2. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 6 AMPS. AT 240 V. A-C

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH COMMON 120 V. A-C SUPPLY FOR INSTRUMENT AND LOADS

L-TYPE CONTROL



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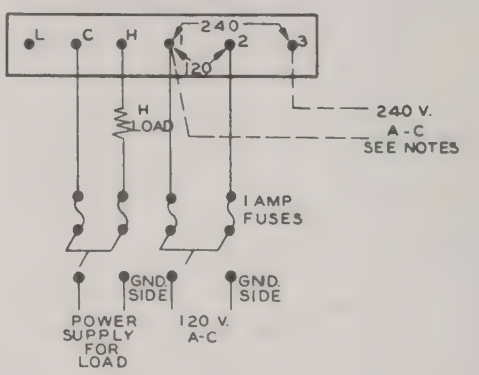

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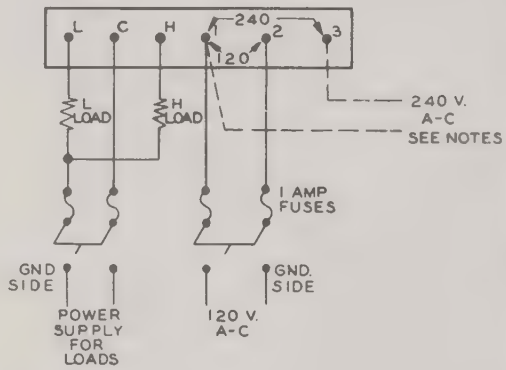
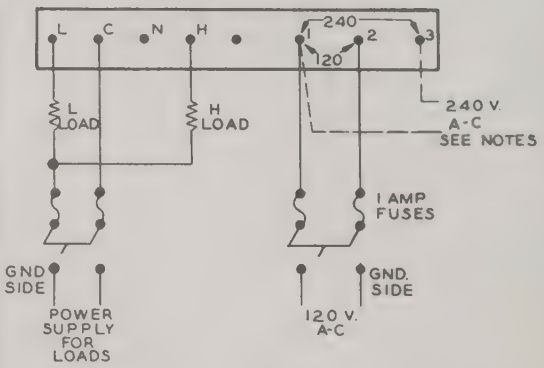


LOH-TYPE CONTROL



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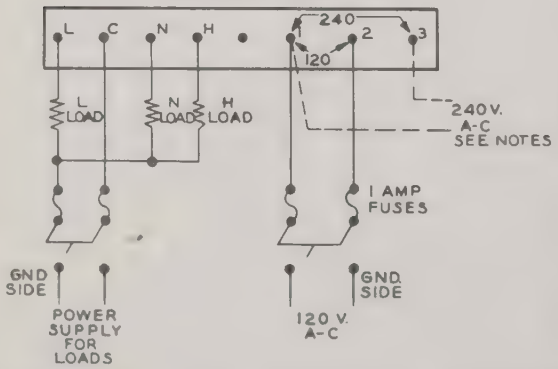
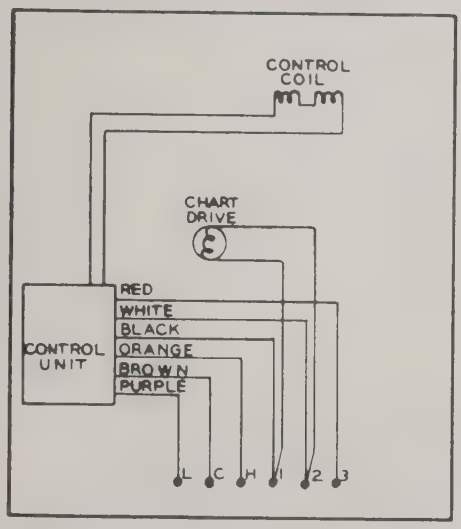


NOTES:-

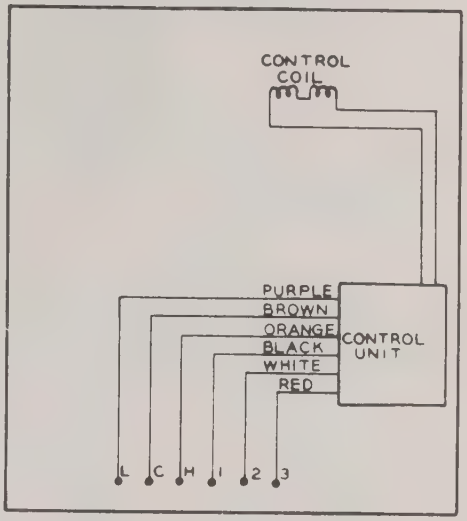
1. THE POWER SUPPLY TO THE CONTROLLER MAY BE EITHER 120 VOLTS OR 240 VOLTS A-C.
2. FUSED LINE SWITCHES FURNISHED BY CUSTOMER.
3. LOAD CIRCUIT CONTACTS IN CONTROLLER ARE LIMITED TO A NON-INDUCTIVE CAPACITY OF 15 AMPS. AT 120 V. A-C OR 8 AMPS. AT 240 V. A-C.

EXTERNAL WIRING DIAGRAM
SERIES 500 ELECTRONIC CONTROLLERS
WITH SEPARATE SUPPLY FOR INSTRUMENT AND LOADS

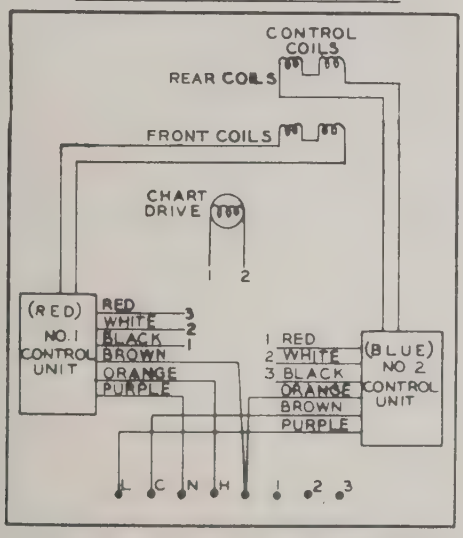
RECORDER WITH SINGLE CONTROL UNIT



INDICATOR WITH SINGLE CONTROL UNIT



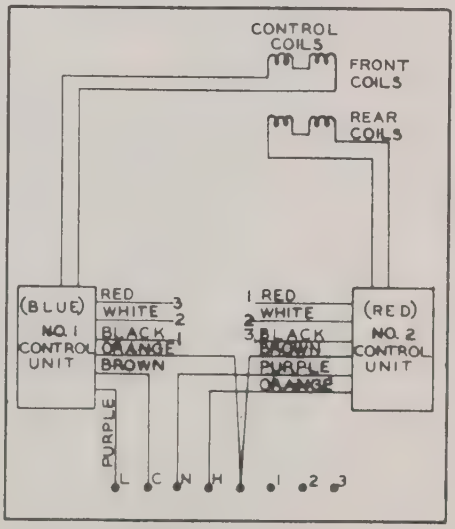
RECORDER WITH TWO CONTROL UNITS



NOTE: REAR VANE LEADS FRONT VANE INTO CONTROL COILS.

RECORDER WITH FIXED 2% BAND & 2 CONTROL UNITS

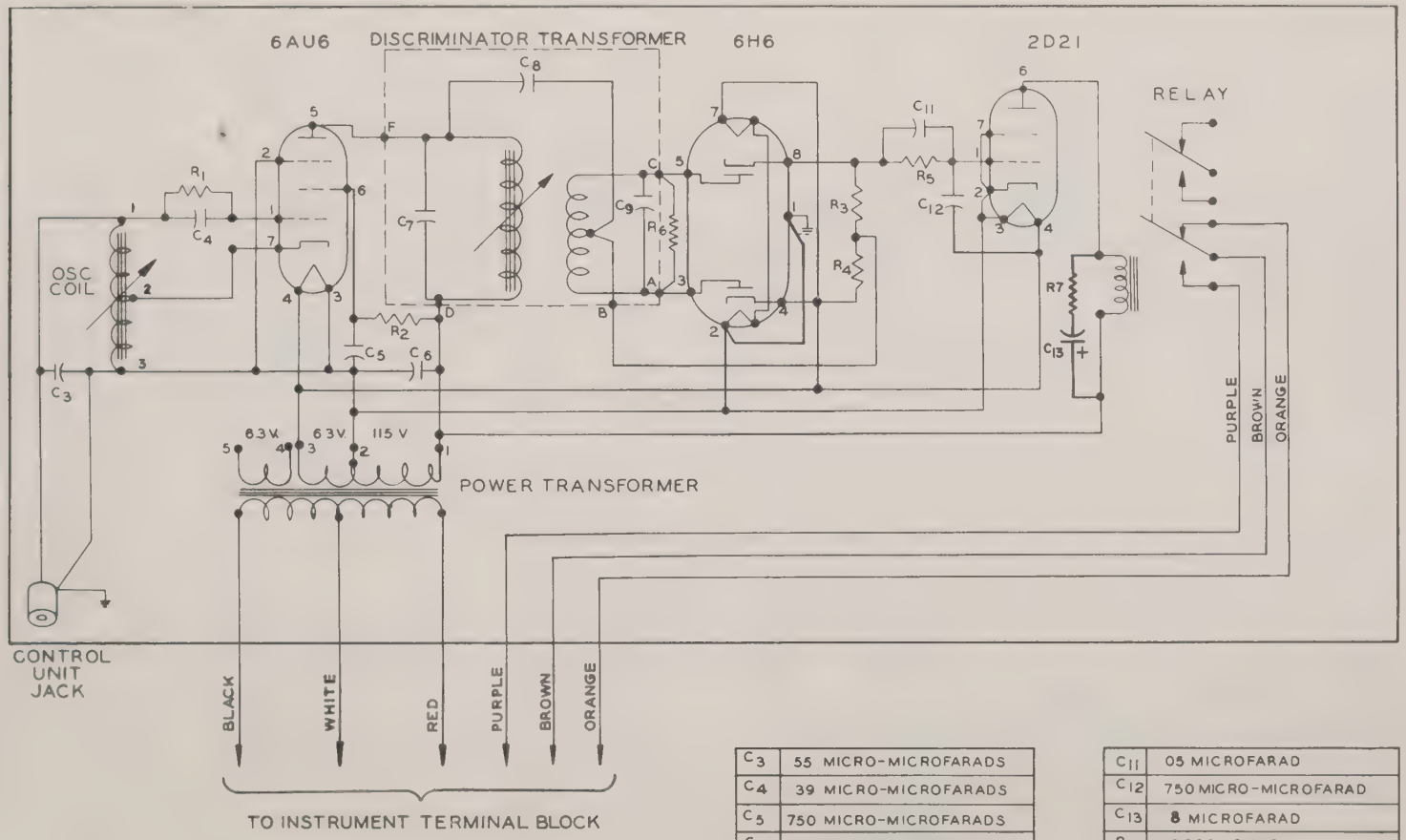
INDICATOR WITH TWO CONTROL UNITS



NOTE: FRONT VANE LEADS REAR VANE INTO CONTROL COILS.

INTERNAL WIRING OF STANDARD SINGLE & DOUBLE CONTROL UNIT SERIES 500 ELECTRONIC CONTROLLERS EQUIPPED WITH 1959 DESIGN DIFF. PEN MOUNTINGS FOR SERIAL NO. 719296 & ABOVE

ELECTRONIC CONTROL UNIT



C_3	55 MICRO-MICROFARADS
C_4	39 MICRO-MICROFARADS
C_5	750 MICRO-MICROFARADS
C_6	750 MICRO-MICROFARADS
C_7	SUPPLIED WITH
C_8	DISCRIMINATOR
C_9	TRANSFORMER

C_{11}	05 MICROFARAD
C_{12}	750 MICRO-MICROFARAD
C_{13}	8 MICROFARAD
R_1	15,000 OHMS
R_2	47,000 OHMS
R_3	150,000 OHMS
R_4	270,000 OHMS
R_5	2.2 MEGOHMS
R_6	270,000 OHMS
R_7	270 OHMS

SCHEMATIC WIRING OF CONTROL UNIT

THE BRISTOL COMPANY
Waterbury 20, Conn., U.S.A.

PARTS LIST FOR BRISTOL'S® SERIES 500 TWO-CASE ELECTRONIC FREE-VANE® PROGRAM CONTROLLER. (ONE OR TWO CAM)

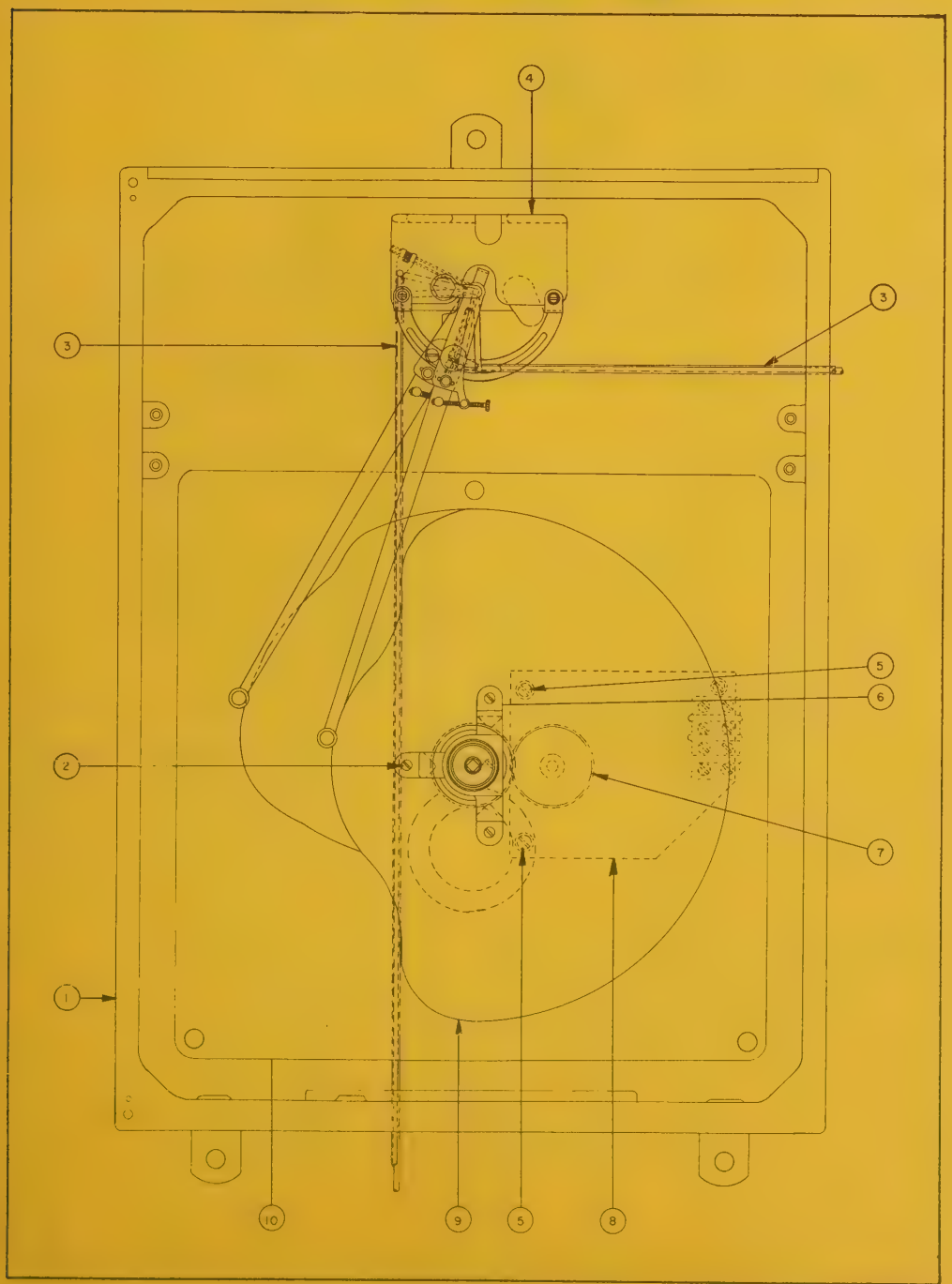


FIGURE 1. FRONT VIEW OF CAM CASE.

© AMERICAN CHAIN & CABLE COMPANY, INC

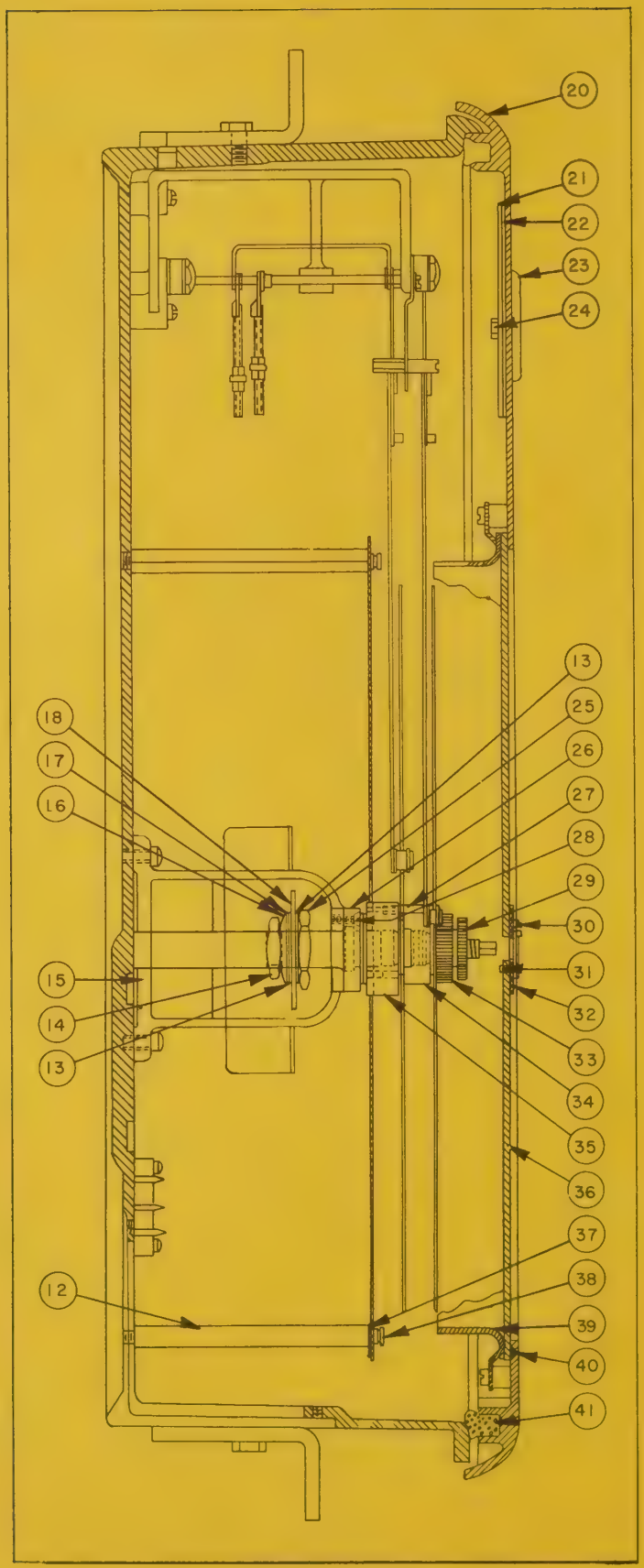


FIGURE 2. SIDE VIEW OF CAM CASE.

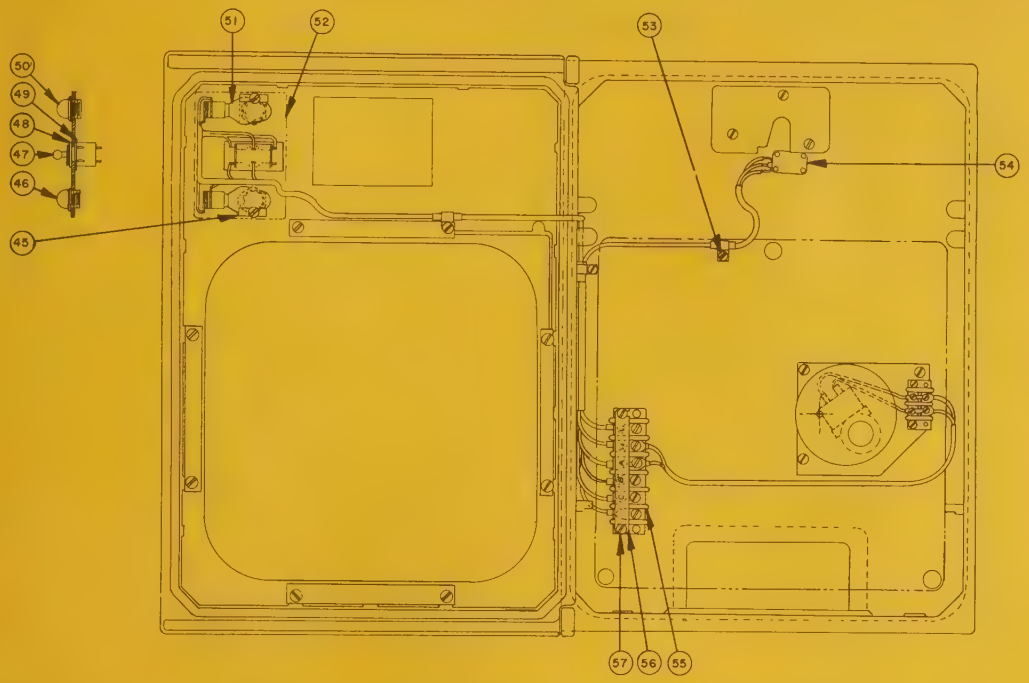


FIGURE 3. CAM CASE SHOWING STANDARD ATTACHMENTS.

ITEM	PART. NO.	DESCRIPTION
		APPLIES TO FIGURES 1, 2 & 3.
1		Case complete (specify model & serial numbers of instrument)
2	66541	#10-32 x 1/2" Fillister-head screw
3	93536	Links (used with 2-case 2-cam, 2-case 1-cam) program component of Horizontally linked program controller.
	94616	Links (used with 2-case 2-cam, 2-case 1-cam) program component of Vertically linked program controller.
4		Cam follower mountings
	B2178	Used on all 1-cam horizontally linked program controllers
	B2182	Used on all 1-cam vertically linked program controllers
	B2177	Used on all 2-cam horizontally linked program controllers
	B2179	Used on all 2-cam vertically linked program controllers
5	35882	#6-40 x 1/2" Fillister-head screw
	60125	Washer
6	94979	Counter shaft complete
7	94606	Spur gear complete
	82404	#6-40 x 3/16" Set-screw
8		Cam drive (standard) specify spindle speed, voltage, frequency and type of motor. Specify model & serial no. of instrument. Cam drive assembly with change gears, refer to page 5.
9		Cam, order as required, specify model & serial no. of instrument
10	93558	Dial plate
12	94987	Dial plate post
13	79236	Clutch facing
14	75856	1/2" - 27 Hex nut
15	94980	Casting
16	96004	Spider washer
17	79237	Washer
18	94983	Gear (78T - 48P)

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
20	A7418	Case cover complete
21	86800	Name plate cover
22	93569	Name plate
23	85155	Emblem plate
24	13775	Nut
25	93529	Hub
26	88086	Bearing housing
	94981	Shaft with bearing
27	93551	Pin
28	21988	#4 - 48 Flat-head screw
29	94986	1/4" - 20 Nut
30	94621	#3 - 56 Shoulder screw
31	12613	#3 - 56 x 1/8" Flat-head screw
32	94620	Key hole
33	94625	1/2" - 27 Nut
34	93556	Spacer nut
35	93555	Spacer for cams
36	94612	Glass
37	93559	Washer
38	66625	Thumb screw
39	82642	Shield
40	84725	Gasket (under glass)
41	82608	Gasket (large groove)
45	96009	Bracket
46	77800	Socket assembly complete (red)
47	56496	Double pole, double throw switch
48	67030	Nameplate ON - OFF
49	76294	Insulation
50	77801	Socket assembly complete (green)
51	46516	Lamp bulb 120 V. } as required
	77913	Lamp bulb 240 V. }
52	96008	Shield
53	88824	#6 Self-tapping screw
54	96002	End of cycle switch
55	87238	Terminal block (6 point)
56	87629	Marking strip
57	85549	#10-32 x 7/8" Fillister-head screw
	72166	Spacer

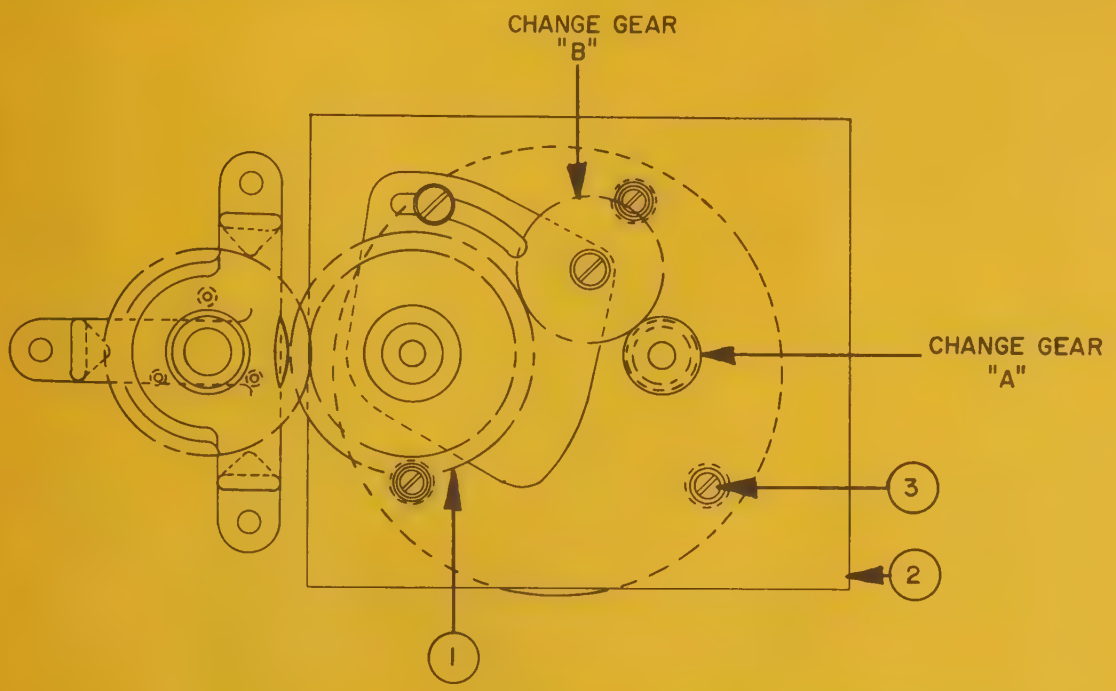


Figure 4. Optional cam drive with change gear assembly.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	A6966	Gear complete 78T and 96T
2	A6964	Mounting plate complete
3	20860	#4 - 48 x 1/4" Fillister-head screw
	A6916	Washer

INTERCHANGEABLE SPEEDS FOR TWO CASE RECORDING PROGRAM CONTROLLER
SERIES 500

CAM DRIVE MOTORS						CHANGE GEARS			
PART 75303 30 MIN./REV.	PART 87351 96 MIN./REV.	PART 75308 6 HR./REV.	PART 75312 24 HR./REV.	PART 75314 72 HR./REV.	PART 75315 7 DAY/REV.	GEAR POSITION	NO. OF TEETH	PITCH	PART NO.
TIME PER CAM ROTATION									
10 Min.	32 Min.	2 Hr.	8 Hr.	1 Day		A B	96 54-18	48 48	A6951 A6953
20 Min.	64 Min.	4 Hr.	16 Hr.	2 Day		A B	96 54-36	48 48	A6951 A6955
30 Min.	96 Min.	6 Hr.	24 Hr.	3 Day	7 Day	A B	96 54-54	48 48	A6951 A6958
40 Min.	128 Min.	8 Hr.	32 Hr.	4 Day		A B	48 54-36	48 48	A6950 A6955
60 Min.	192 Min.	12 Hr.	48 Hr.	6 Day	14 Day	A B	48 54-54	48 48	A6950 A6958
80 Min.	256 Min.	16 Hr.	64 Hr.	8 Day		A B	24 54-36	48 48	A6960 A6955
120 Min.	384 Min.	24 Hr.	96 Hr.	12 Day	28 Day	A B	24 54-54	48 48	A6960 A6958

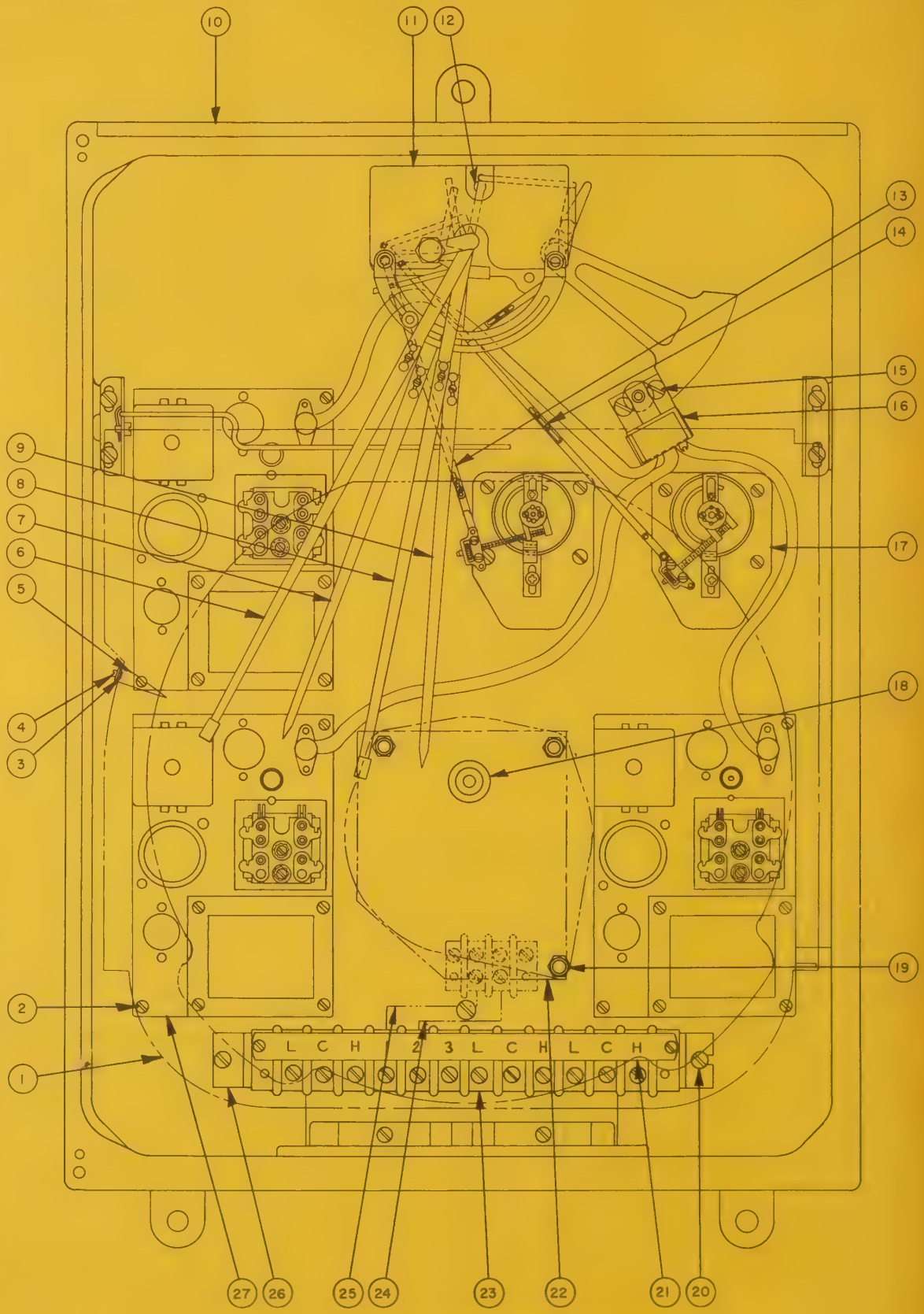


FIGURE 5. FRONT VIEW OF TYPICAL CONTROLLER CASE.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	84728	Dial
2	90670	#8-32 x 1 1/2" Fillister-head screw
3	87118	#2-64 Nut
4	67694	Hex head screw
5	84724	Time indicator
6	90651	Pen arm (FG) for No. 2 pen on a 2-pen instrument
	32915	Pen for No. 2 pen on a 2-pen instrument
7	90652	Control spotter arm
8	90650	Pen arm (FH) for single pen instrument and is No. 1 pen arm on a 2-pen instrument
	32914	Pen for single pen instrument and is No. 1 pen on a 2-pen instrument
9	90653	Control spotter arm
10		Case complete (specify model & serial numbers of instrument)
11		Differential pen mounting complete. (Specify model and serial No. of instrument.)
12	66545	#10-32 x 3/4" Fillister-head screw
13	86675	Adjustable connecting link
14	86678	Adjustable connecting link
15	66537	#10-32 x 1/4" Fillister-head screw
16		Control coil unit complete including mounting bracket and cable.
	B2213	For one-cam, one-control unit controller
	B2296	For one-cam, two-control unit controller
	B2296	For two-cam, two-control unit controller
	B2306	For two-cam, three-control unit controller
17		Measuring element. (Specify model, range & serial No. of instrument.)
18	74986	Chart hub
19	39770	#6-40 x 1/4" Fillister-head screw
20	66537	#10-32 x 1/4" Fillister-head screw
21	A6716	Marking strip
22		Chart drive specify spindle speed, voltage, frequency and type of motor.
23	88098	Terminal block (12 point)
24	86745	Pigtail (white) } order only with electric chart drive
25	86746	Pigtail (black) }
26	76253	Terminal block mounting bracket
27	90578	Control unit complete (50-60 cycle) see pages 8 & 9 for breakdown

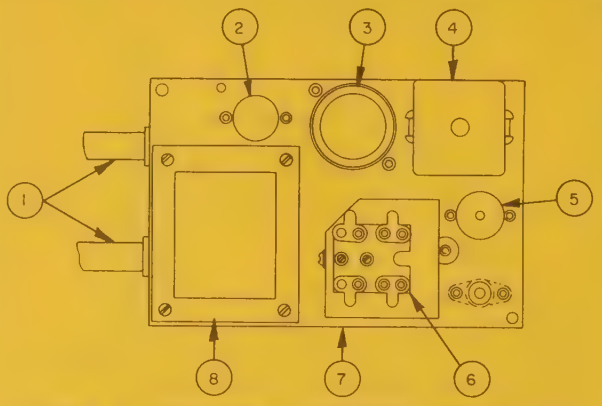


Figure 6. Top view of electronic control unit.

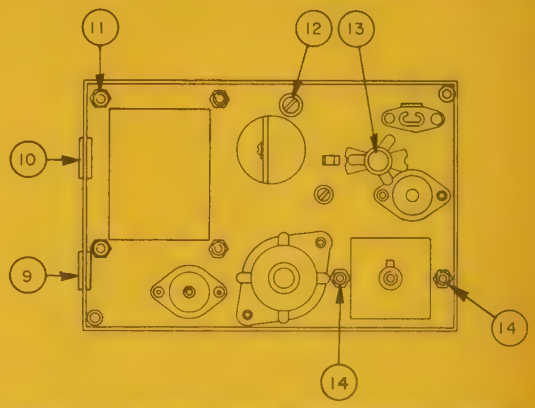


Figure 7. Bottom view of electronic control unit.

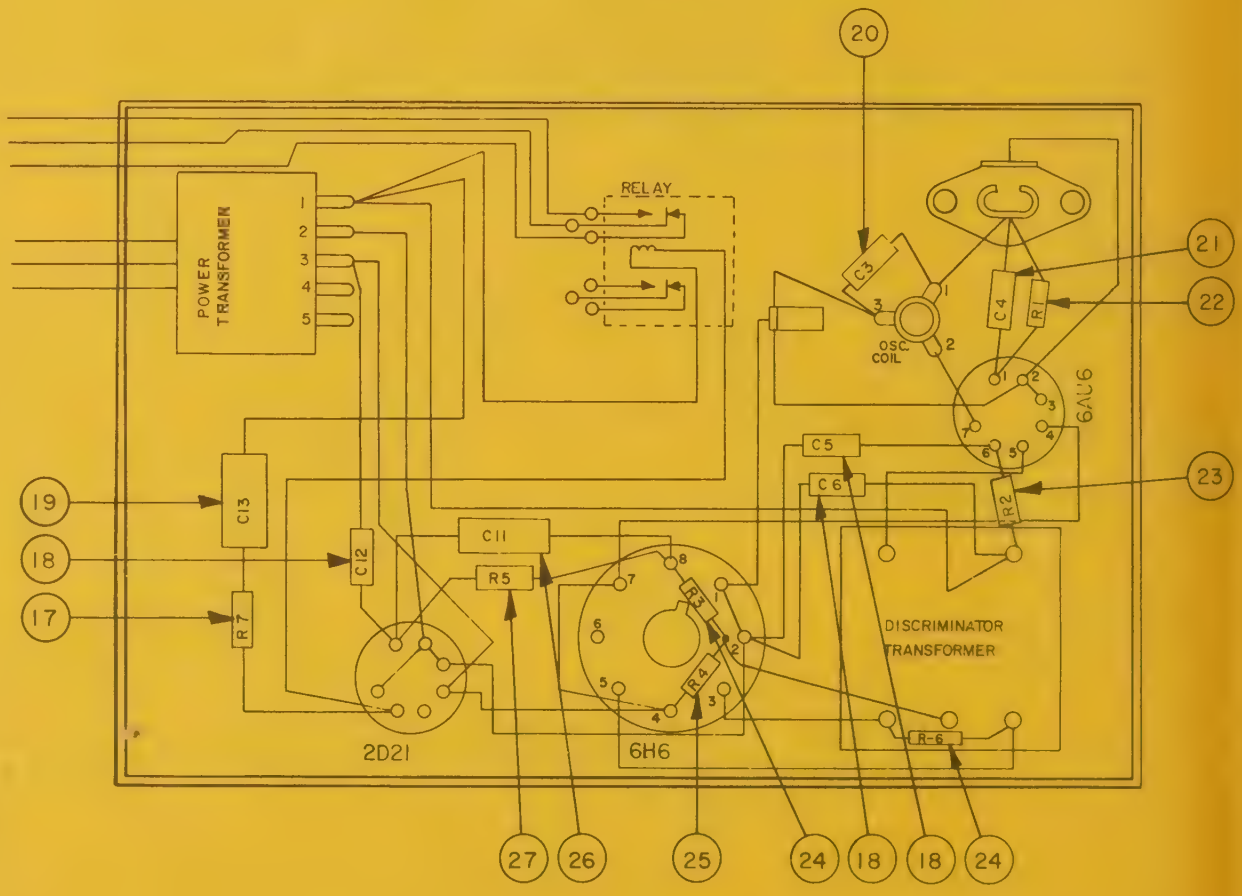


Figure 8. View showing components of electronic control unit.

BE SURE TO STATE MODEL AND SERIAL NUMBERS OF INSTRUMENT WHEN ORDERING PARTS

ITEM	PART NO.	DESCRIPTION
1	85108	Insulation sleeving
2	90555	Tube 2D21
3	90553	Tube 6H6
4	90573	Discriminator transformer
5	90554	Tube 6AU6
6	90570	Relay
7	C1091	Chassis complete
8	90576	Power transformer 50-60 cycle
	90577	Power transformer 25 cycle
9	95912	Grommet
10	79767	Rubber grommet
11	92923	#6-32 Hex nut
	33982	#6 Lockwasher
12	63384	#6-32 x 5/16" Fillister-head screw
	33982	#6 Lockwasher
13	90569	Oscillator coil
14	92923	#6-32 Hex nut
	33982	#6 Lockwasher
17	A2886	(R7) Resistor, 270 ohms
18	90560	(C5, C6, C12) Capacitor 750 MMFD
19	92727	(C13) Capacitor, 8 MFD
20	91431	(C3) Capacitor, 55 MMFD
21	90562	(C4) Capacitor, 39 MMFD
22	90556	(R1) Resistor, 15,000 ohms 1/2 watt
23	83977	(R2) Resistor, 47,000 ohms 1 watt
24	90557	(R6) Resistor, 270,000 ohms 1/2 watt
25	87019	(R3) Resistor, 150,000 ohms 1/2 watt
26	77701	(C11) Capacitor, .05 MFD
27	89087	(R5) Resistor, 2.2 megohm 1/2 watt

CASE CONNECTIONS & MEASURING SYSTEM COLOR CODE FOR DIAL INDICATING & RECORDING THERMOMETER. 1 TO 4 PENS

TUBING & CONDUIT CONNECTIONS ARE MADE TO NUMBERED POSITIONS OF SPLIT CONNECTION PLATE AS SHOWN BELOW.

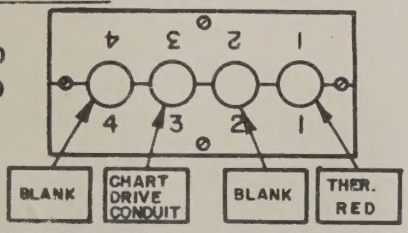
NOTE: 1. ALL CONDUIT CONNECTIONS ARE FOR 1/2" S.P.T.
2. OMIT CHART DRIVE CONDUIT FOR INDICATORS AND SPRING DRIVEN RECORDERS.

NUMBERS ARE FROM RIGHT TO LEFT LOOKING FROM REAR OF CASE

DRAWN J.J.R. | DATE 7/21/47 | APPROVED
TRACED J.A.D. JR. | CHECKED | FILE DR. 21
SCALE | NO. 011037

1 PEN THERMOMETERS

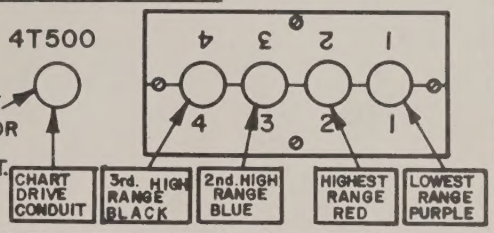
MODEL 1T500
MODEL 1T530



4 PEN THERMOMETERS

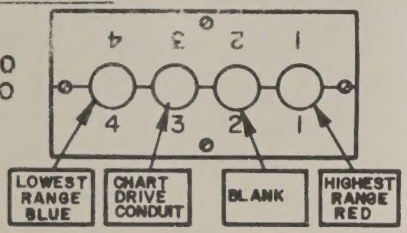
MODEL 4T500

SPECIAL DRILL IN CASE FOR RUBBER GROMMET.



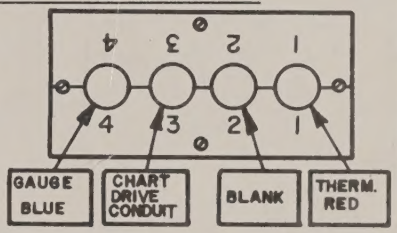
2 PEN THERMOMETERS

MODEL 2T500
MODEL 2T530



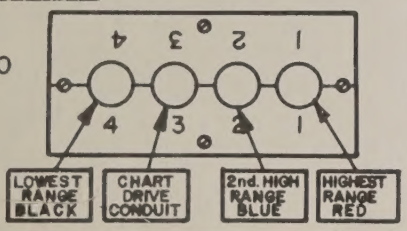
2 PEN 1 GAUGE & 1 THERMOMETER

MODEL 1L500
MODEL 1L530



3 PEN THERMOMETERS

MODEL 3T500



THE BRISTOL COMPANY
WATERBURY, CONN. U.S.A.

REVISIONS
11-28-61
4-12-48

NO. 011037

PRODUCTS OF
AMERICAN CHAIN & CABLE COMPANY INC.

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MATERIAL HANDLING GROUP

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CANADIAN WARREN PINK division of Dominion Chain Company Limited
St. Catharines, Ontario and Vancouver, British Columbia
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CANADIAN MECHANICAL HANDLING SYSTEMS LTD., Windsor, Ontario

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MHS INTERNATIONAL, Inc., Watford, Herts
PARSONS CHAIN COMPANY Limited
BRITISH WIRE PRODUCTS Limited, Stourport-on-Severn, Worcestershire

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